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Nancy L. Nihan, Morgan Wong

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Washington State Transportation Center (TRAC)
University of Washington, JD-10
University District Building, Suite 535
1107 NE 45th Street
Seattle, WA 98105-4631

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16. ABSTRACT

This research project evaluated an algorithm developed in the previous project (Nihan et al., *Detector Data Validity*), and developed a new data error detection algorithm by employing a video imaging data collection technology called Autoscope™. This new algorithm was calibrated with data from the Seattle metropolitan area. It helps to determine the reliability of 20-second loop detector data that are used for the operation of the ramp metering system.

Both the existing and the new algorithms were tested for their effectiveness with an extensive data set that contains manually simulated erroneous data. The test data were collected from various locations on I-5 that covered different characteristics such as lane type, lane configuration, and geometric. While both algorithms were effective in screening out hanging-off errors, chattering, and spurious pulses, the new algorithm provides a much more effective detection for hanging-on errors, especially in congested conditions.

The principal findings and recommendations of this research were as follows:

1. The Autoscope™ data collection results were checked against itself for internal consistency and tested against manual counts for accuracy. We have found that the results were consistent with the developer's claim of an accuracy level of 92.18 percent to 98.32 percent for traffic counts.
2. The new error detection algorithm resulted from this project showed a marked improvement over the original one, especially in screening out the hanging-on errors that occur in congested conditions.
3. The feasible region of volume/occupancy data fell within two parabolic envelopes, substantiating the traditional understanding of this relationship.
4. Except for chattering data and spurious pulses (which are treated as erroneous data), the other error flags can denote either detector malfunctions, or the existence of some "abnormal" traffic pattern, such as that caused by an incident. Therefore, the recognition of the erroneous data's location can possibly help to identify incidents happening in congested traffic. However, since this particular function has not been tested in this project, it may be an issue worthy of future investigation.
5. A preliminary investigation of the relationship between vehicle length and the *g*-value was done; and empirical 20-second data supported the theoretical understanding of this relationship. It was recommended that studies with different time-slices be done to further investigate this relationship.
6. The new error detection algorithm can be implemented in the WSDOT control system in the Seattle I-5 corridor. It will improve the integrity of the loop data, and hence, improve ramp control and freeway operation.

The Autoscope™ system can be used for algorithm development and for calibration of other facilities, such as HOV lanes. It can also be used for real-time data collection, analysis, and traffic control particularly at construction sites, where detection loop operations are usually interrupted.

17. KEY WORDS

Loop Detectors, Error Detection, Incident Detection, Video Imaging

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Research Project T9233, Task 18
Improved Error Detection

IMPROVED ERROR DETECTION USING PREDICTION TECHNIQUES AND VIDEO IMAGING

by

Nancy Nihan
Principal Investigator

Morgan Wong
Research Assistant

Washington State Transportation Center (TRAC)
University of Washington, JD-10
University District Building, Suite 535
1107 NE 45th Street
Seattle, Washington 98105-4631

Washington State Department of Transportation
Technical Monitor
Peter M. Briglia
ITS Program Manager

Prepared for

Washington State Transportation Commission
Washington State Department
of Transportation
Olympia Washington 98504-7370

Transportation Northwest (TransNow)
135 More Hall, FX-10
University of Washington
Seattle, Washington 98195

and in cooperation with
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EXECUTIVE SUMMARY

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INTRODUCTION AND RESEARCH APPROACH

THE PROBLEM

A survey of 32 major freeway projects in North America reported that only 19 had detector data error checks, and even those were fairly primitive and crude (Chen and May, 1987). Most of these systems use upper- and lower-limit tests for volume and occupancy. However, the ratio of upper and lower limits of acceptable values for the volume tests is often 10:1 or higher; a commonly accepted occupancy range allows values from 1 percent to 95 percent. The rough checks in such systems can hardly be trusted to meet the data needs of the advanced traffic control systems of the current IVHS era.

The ramp control system currently in place on I-5 in Seattle is traffic-responsive. The system thus relies on data from inductive loop detectors for control algorithms, incident detection, traffic information, and system performance measures. When detectors malfunction, the system's integrity is compromised by inaccurate data. System reliability and performance can be enhanced through improved data screening. A previous WSDOT/TransNow project (Nihan et al., 1990; Jacobson et al., 1990) developed a data-screening technique based on data from the Ontario, Canada, freeway system. While it was shown that the technique detects errors in the Seattle freeway loops that had previously gone undetected, the simulations done to substantiate this conclusion were very limited. Furthermore, it was recommended that the algorithm formulation be calibrated with local traffic data to fine tune the error detection algorithm.

RESEARCH OBJECTIVES

As an extension of the previous effort, this project has the following objectives:

1. Evaluate data gathered in the course of the Detector Data Validity project (Nihan et al., 1990). Develop ways to improve the detector data validity algorithm and investigate relationships for ramp control and incident detection.
2. Collect speed, volume, and occupancy data from the I-5 CCTV surveillance system.
3. Use a video camera and computer to evaluate video imaging for an independent check on volume, lane occupancy, and speed relationships. Use the video-imaging system to develop parameters to describe volume, lane occupancy, and speed relationships in the Seattle area.
4. Evaluate the effectiveness of video imaging for incident detection and speed-sensing applications.

BACKGROUND

Error Detection Algorithms

The literature review revealed that very little research has been devoted to the area of loop detector data error screening. Two recent research projects constitute the background for this project. The first is an enquiry into erroneous loop data detection, sponsored jointly by the WSDOT and TransNow. In this project, Nihan, Jacobson, Bender, and Davis (1990) found that the Washington algorithm (hereinafter called the Original NJBD Algorithm) provides a much better mechanism for screening out bad data. Besides using some upper- and lower-limit macroscopic tests, the Seattle research team also used volume-to-occupancy ratios to test 20-second volume and occupancy data. However, while this algorithm had some success in identifying hanging-off errors where the detector cuts short vehicle time, it could not identify hanging-on errors where the detector overcounted vehicle presence time because hanging-on errors are easily mistaken for congestion data.

The authors also suggested a few obvious problems with the Original NJBD Algorithm. First, the algorithm's thresholds were developed with data from a different system which uses 30-second data. These thresholds were calibrated through a trial-and-error process, which is not optimal. Second, the occupancy ranges used by the algorithm were so large that severe discontinuities could be observed at the range boundaries. Third, the algorithm was not tested thoroughly enough at different grades and locations.

A second project in loop data screening was carried out in Ontario, Canada. Cleghorn, Hall, and Garbuio (1991) suggested a few screening methods with both single and paired detector loops. The researchers provided some very interesting insights into the upper limits beyond which the data are considered erroneous. However, they did not deal with the congested side of the spectrum, where occupancies are high at very low volumes. If, as we have recognized, most of the erroneous data occur at congested conditions, then Cleghorn et al.'s screening methods are not very effective.

This project is therefore designed to further develop the Original NJBD Algorithm with local 20-second data, and to improve the performance of erroneous data detection in the congested traffic condition.

Autoscope™ Video Imaging System

Description of Autoscope™

In the pursuit of more accurate data, many researchers have turned to technologies beyond induction loops: infra-red and various forms of video imaging, to name a few. A group at the University of Minnesota developed the Autoscope™ (Michalopoulos, et al., 1990) system which employs video-imaging technology. The Autoscope™ uses the tripwire detection method, which mimics the loop detection approach.

The system works by feeding the image from a video source (video camera or VCR) into both the Autoscope™ video-image processor and into the video-image digitizer in the supervisor computer (see Image Sensing Systems, 1991). Proprietary software, run under Microsoft® Windows™, is used to operate Autoscope™. The Setup program is used to place detectors on the video monitor screen. There are two types of detectors: presence detectors and speed traps. Presence detectors are lines drawn with a mouse on the digitized image. When a vehicle passes over a detector (line on the screen), it is actuated by the color (gray scale) difference between the vehicle and the pavement. A speed trap is a small rectangular box, connected behind a presence detector, drawn on the screen. The Autoscope™ operator inputs the length of the speed trap. The system uses the length of the speed trap and time taken for a vehicle to traverse it to calculate speed.

A second program, the Control Panel, configures the Autoscope™ system, and collects and analyzes data. The Control Panel sends the detector configuration created by the Setup program to the Autoscope™ processor and then receives traffic data from the video detection. The Control Panel uses these detection data to generate the traffic parameters: volume, flow, speed, headway, lane-occupancy, and vehicle classification.

Although Autoscope™ has competitors, it is the most advanced and well tested system for traffic engineering applications. The first available model of Autoscope™, model 2002, was used for this project.

Accuracy of Autoscope™

Autoscope™ developers have tested the system in the field at various locations (Michalopoulos, Wolf, and Benke, 1990). At the Minnesota test site, they reported overall accuracy levels of 92.18 percent to 98.32 percent for volume counts, and accuracy levels of 94.57 percent to 97.66 percent for speed data. These accuracy levels were achieved under relatively difficult conditions: congestion, vehicle shadows, tree shadows, and transition to dusk.

Another field test by Autoscope™ developers was carried out at Oakland County, Michigan, in an IVHS program named FAST-TRAC (Michalopoulos, Jacobson, Anderson, and Barbaresso, 1992, 1993). FAST-TRAC represented the largest application to date of video detection and integration with adaptive control; the application covered a network of 28 intersections. Tested under various conditions, including high winds, shadows, overcast, snow, day/night transition, and night, the researchers reported overall accuracies between 96.1 percent and 99.6 percent for volumes, and occupancy.

A project at Cal Poly, San Luis Obispo evaluated the performance of eight different image-processing systems (Hockaday, 1991). Twenty-eight tests were performed with these systems; these tests included the following factors: different camera positioning, different lane configurations, different weather conditions, day/night transitions, day and night conditions, and different traffic directions. The Autoscope™ system was described as "reliable" and the software on the user interface was termed "very convenient." The average levels of error under "ideal conditions" were 0.3 percent for volume counts and 5 percent for speed calculations. The higher percentage of error for the speed calculation was due to the difficulty in calibrating speed traps. Herein lies the system's main drawback: the operator is responsible for placing both the detectors and the speed traps in the optimal position. Fortunately, this difficulty has been greatly reduced by the newer model of Autoscope™, model 2003, which requires that the user input only the distance between two points on the screen, and the camera height measurement.

The Application of Autoscope™

The Autoscope™ 2002 system was the data collection tool for this project. Freeway data were taped with WSDOT TSMC surveillance cameras. The Autoscope™ system then analyzed these videotapes. However, there are a few caveats to this process.

First, to avoid occlusion problems associated with camera angle, the video camera must be placed high enough above the freeway surface, that it can be adjusted to view almost directly vertically down to the freeway. The camera used for data collection in this project was mounted on a pole on an overpass, approximately 60 feet above the roadway. This is why we were restricted to collecting data from I-5, instead of from the I-90 tunnel, as originally proposed, where the cameras are placed too low and where camera angles are not adjustable from the TSMC. Since the purpose of using Autoscope™ in this project is to collect the most accurate data, the weather conditions for the data collection periods were all ideal sunny and clear ones.

Second, the camera must be fixed for the duration of the data collection period. This often posed a problem because the congested data required for this project had to be collected during peak periods, when the surveillance cameras were most needed to move around for their primary purpose--surveillance. That is why the site selected for this data collection effort was at the northern-most camera just outside King County, looking at the northbound lanes of I-5 at 236th St SW, where demand for the camera was considerably lower than for the rest of the cameras on the I-5 corridor within the Seattle city limits.

Third, the Autoscope™ system has to be calibrated meticulously for every camera position. To reiterate, the system's accuracy depends solely on the accuracy of the calibration.

FORMULATION

Basic Relationships

Typically, the relationship between flow, density, and speed is given by the fundamental traffic flow equation:

$$q = k \times u \tag{1}$$

where q = flow (veh/hr),

u = space mean speed (mph), and

k = density (veh/mile)

However, because measuring density is very difficult, if not impossible, the parameter is usually presented in terms of lane-occupancy. The relationship between density and lane-occupancy, is given by the following:

$$k = g \times o \tag{2}$$

where g = conversion factor, and

o = lane-occupancy (percent)

Investigations by Hall and Persaud (1989) have indicated that g is not constant. They have concluded that g changes with occupancy and geometric conditions (e.g., grades). Therefore, the relationship represented by Equation 2 is non-linear.

Actually, one expects the relationship to be non-linear even if occupancy and geometric conditions are constant. This is quite clear from relationship given in *Traffic Flow Theory* (Gerlough and Huber, 1975):

$$\hat{k} = \frac{o}{100} \times \frac{5280}{L_e} \tag{3}$$

where $\hat{k}$ = estimated density (veh/mile)

o = lane occupancy (percent)

L_e = effective vehicle length (feet)

Because effective vehicle length varies with every vehicle, the relationship between density and occupancy cannot be linear. Hall et al. (1989, 1993) and Pushkar et al. (1994) also indicated that unless vehicle length or speed is uniform, a constant conversion factor between occupancy and density has very limited validity. This relationship was studied in greater depth and is presented later in this report.

Although we have seen that Equation 2 is not a linear relationship, we can still use the relationship to calculate the value of g for every 20 seconds. Substituting Equation 2 into Equation 1, we derive g as a function of volume, occupancy, and speed.

$$g_{20} = \frac{q}{o \times u} = \frac{Vol20 \times 180}{Occ20 \times \bar{u}_s} \tag{4}$$

where g_{20} = g-value for a 20-sec period,

$Vol20$ = observed 20-sec volume (veh/20-sec),

$Occ20$ = observed 20-sec lane-occupancy (%),

$\bar{u}_s \cong \bar{u}_t - \frac{\sigma_t^2}{\bar{u}_t}$ = estimate of space mean speed averaged over 20 sec.(mph),

$\bar{u}_t$ = observed time mean speed averaged over 20 sec. (mph),

σ_t^2 = variance of the time mean speed, and

q and o are as defined previously

Original NJBD Error Detection Algorithm

Nihan and the Seattle team used the 30-second volume, occupancy, and speed data collected by Hall and Persaud from median lane paired inductive loops detectors at four different stations from Burlington Skyway and Mississauga FTMSs on Queen Elizabeth Way in Ontario, Canada. Appropriate metric and 30- to 20-second conversions were made to the data. They calculated the g-factor for each period by using Equation 4. For each occupancy range, the average g-factor and the corresponding 95 percent confidence interval were calculated. The confidence limits were calculated using Equations 5a and 5b.

$$g_{ulr} = \bar{g}_r + t_{\alpha,n-1} \frac{s_r}{\sqrt{n_r}} \tag{5a}$$

$$g_{llr} = \bar{g}_r - t_{\alpha,n-1} \frac{s_r}{\sqrt{n_r}} \tag{5b}$$

where g_{ulr} = upper limit of g for occupancy range r

g_{llr} = lower limit of g for occupancy range r

$\underline{\alpha}$ = level of significance = 0.05

$\bar{g}_r$ = average g for occupancy range r

n_r = number of observations in the occupancy range r

s_r = standard deviation of the observations in the occupancy range r

$t_{\alpha,n-1}$ = t-statistics

The researchers chose to use four occupancy ranges suggested by Hall and Persaud, namely, 0.1-7.9 percent, 8.0-25.9 percent, 26.0-35.9 percent, and 36 percent or higher. Then they determined the maximum and minimum speeds for each occupancy range. Finally, the researchers selected the minimum and maximum *g*-factors and speeds for each occupancy range and used the values to calculate the maximum and minimum volume/occupancy ratios for each. These volume/occupancy ratios (or slopes) of the data envelope were obtained by Equations 6a and 6b; the minimum 20-second volumes were calculated by Equations 7a, and the maximum 20-second volumes were calculated by 7b. All calculations are based on 20-second data.

$$(v/o)_{\min r} = g_{llr} \times u_{\min r} \tag{6a}$$

$$(v/o)_{\max r} = g_{ulr} \times u_{\max r} \tag{6b}$$

where $(v/o)_{\min r}$ = calculated minimum Vol/Occ ratio for occupancy range r

$(v/o)_{\max r}$ = calculated maximum Vol/Occ ratio for occupancy range r

$u_{\min r}$ = minimum speed (mph) for occupancy range r

$u_{\max r}$ = maximum speed (mph) for occupancy range r

$$v_{\min} = g_{llr} \times u_{\min r} \times o_{1r} \tag{7a}$$

$$v_{\max} = g_{ulr} \times u_{\max r} \times o_{1r} \tag{7b}$$

where $v_{\min}$ = lower limit of the reliable data envelope

$v_{\max}$ = upper limit of the reliable data envelope

o_{1r} = the occupancy in the beginning of each occupancy range r

and $(v/o)_{\min}$ and $(v/o)_{\max}$ define the slopes of the lower and upper envelopes for reliable data. These limits represent very conservative estimates because the maximum speed is used to multiply the upper limit of the g-value, and minimum speed is used to multiply the lower limit of the g-value.

A summary of the threshold calculations is provided in Table 1.

Table 1. Summary of Threshold Calculations

	Occupancy Ranges			
	0.1 – 7.9	8.0 – 25.9	26.0 – 35.9	36.0 +
Minimum *g*-factor	2.433	2.024	1.754	0.980
Maximum *g*-factor	3.132	2.526	2.462	1.868
Minimum speed (mph)	24.220	18.630	8.690	6.830
Maximum speed (mph)	78.870	78.250	48.440	38.500
Minimum 20-second Volume/Occupancy ratio	0.327	0.209	0.085	0.037
Maximum 20-second Volume/Occupancy ratio	1.372	1.098	0.663	0.400

The logical and graphical representations of the Original NJBD Algorithm are given in Figures 1a, 1b, and 1c below.

Figure 1a. Original NJBD Loop Data Error Detection Algorithm (Flow Chart)

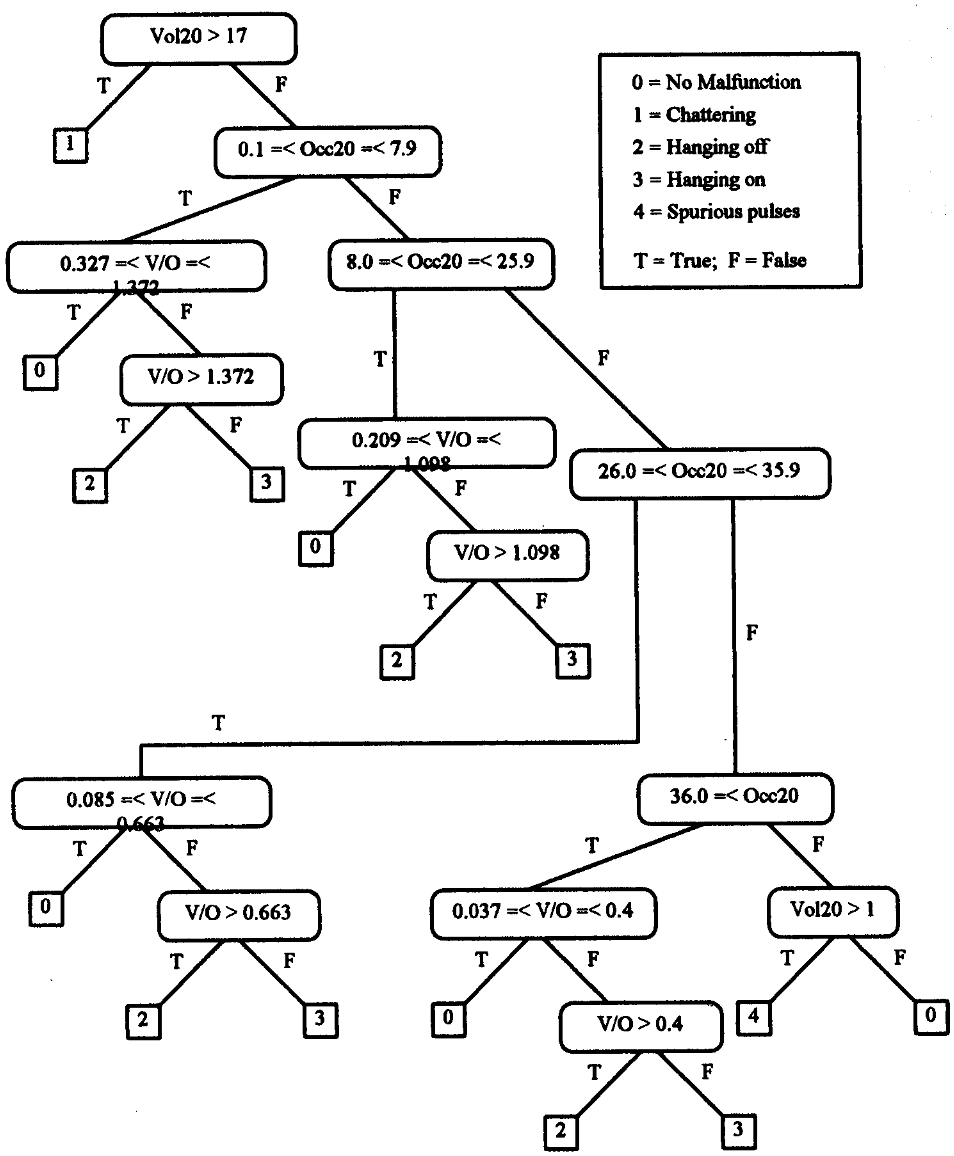
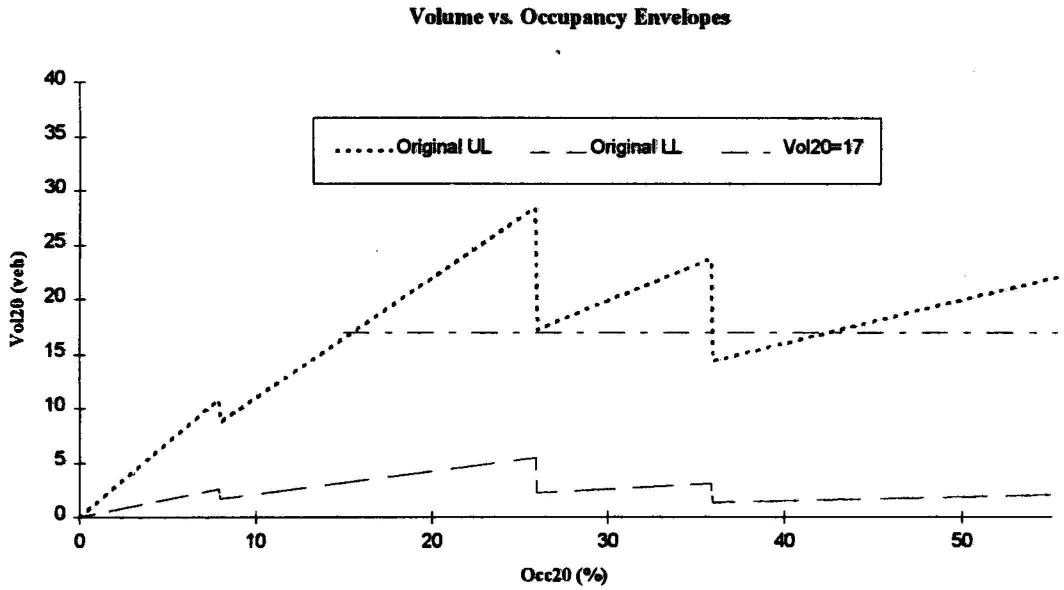


Figure 1b. Original NJBD Loop Data Error Detection Algorithm (Graphical Representation)



The legend labels UL and LL stand for upper limit and lower limit, respectively. These labels are defined consistently throughout this report. The slopes of the curves in each range represent the minimum or maximum *Vol*20/*Occ*20 for each.

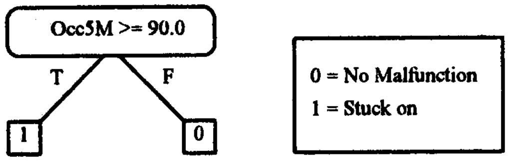
The Original NJBD Algorithm was given in two parts. The first part (Figures 1a and 1b) involved 20-second data. This part of the algorithm identifies invalid data when one of the following conditions occurs:

1. Twenty-second lane volumes (*Vol*20s) exceed 17, which is equivalent to 3060 vehicles per hour; this is a WSDOT criterion. This error, indicated by Flag 1, is a result of chattering. Chattering may occur when a detection signal is broken into short pulses, giving an erroneously high vehicle count. (Chattering may also occur when detected 20-second volumes are below 17 but may not be flagged by this rule. This flag simply eliminates data from chattering loops that produce unrealistically high volumes.)

2. Twenty-second volume/occupancy ratios are above the upper threshold ranges for the four occupancy ranges (0.1-7.9 percent, 8.0-25.9 percent, 26.0-35.9 percent, and greater than 36 percent). This is called hanging off, indicated by Flag 2. Hanging off is the result of the detector reacting very slowly to a vehicle's passage over it; this slow reaction time effectively cuts short the device's detection of the vehicle. The vehicle count is supposedly correct, but the occupancy value is lower than what it should be.
3. Twenty-second volume/occupancy ratios are below the lower threshold ranges for the four occupancy ranges. This is the result of the hanging-on error, indicated by Flag 3. Hanging-on error results from the detector hanging in the ON position after the vehicle has already passed over it. Again, this supposedly gives an accurate vehicle count, but the occupancy value is too high.
4. Twenty-second volumes are greater than one when occupancies are between 0.0 and 0.1 percent. This error, indicated by Flag 4, represents the spurious pulses that are received by the detector amplifier in the absence of any vehicle passage.

The second part of the Original NJBD Algorithm screens the five-minute occupancy (Figure 1c). Occupancies greater than 90 percent are considered indications of unreliable data.

Figure 1c. Original NJBD Loop Data Error Detection Algorithm (Additional Five-min. Occupancy Test)



Development and Calibration of Improved Error Detection Algorithm

Because the existing error detection algorithm thresholds were developed with data from a different freeway system, these thresholds had to be fine tuned with local data as a first step in the project. Instead of collecting speed data with paired-loop detectors (which might themselves be in error), as the Canadians did, the research team used the Autoscope™ system to collect more accurate speed, volume, and occupancy data.

Data Collection

For four hours during the afternoon peak, for three days, the researchers collected video-taped traffic data from I-5 Northbound at 236th SW. After fine calibrations of the Autoscope™ system, each tape was analyzed with the video-imaging system. Traffic flow data--volume, occupancy, and speed--were extracted from the Autoscope™ data files. Since the shortest time slice given by the Autoscope™ system time-slice data output was one-minute, we developed custom software to extract data in 20-second time-slices, which is the unit used by the TSMC. The resulting database has over 5,500 data points (i.e., one value of volume, occupancy, and average speed for each 20-second time-slice).

For each 20-second data point, a *g*-value is calculated with Equation 4. After sorting the *g*-factor according to occupancy, the upper and lower limits of the *g*-value for *each occupancy range* are calculated, by means of Equations 5a and 5b. The researchers developed several *volume/occupancy* (*v/o*) envelopes for error detection and screening with these results.

Development of Error-Screening Algorithms

Jagged Envelopes

With the local data, the first step in developing error-screening algorithms was to follow the formulation described in the previous section, using the same occupancy ranges as in the Original NJBD Algorithm. The results are summarized below in Table 2.

Table 2. Thresholds Calculated from Local Data

	Occupancy Ranges			
	0.1 – 7.9	8.0 – 25.9	26.0 – 35.9	36.0 +
Minimum *g*-factor	2.119	2.367	2.446	2.176
Maximum *g*-factor	2.248	2.386	2.481	2.295
Minimum speed (mph)	42.7	8.2	6.1	4.5
Maximum speed (mph)	65.0	65.0	55.5	35.1
Minimum 20-second Volume/Occupancy ratio	0.503	0.108	0.082	0.054
Maximum 20-second Volume/Occupancy ratio	0.812	0.862	0.765	0.448

This algorithm is depicted graphically in Figure 2. We called this algorithm Alternative A. The Original NJBD Algorithm calculated with the Canada data is superimposed onto the figure for comparison.

Figure 2. Modified Loop Data Error Detection Algorithm (Alternative A)

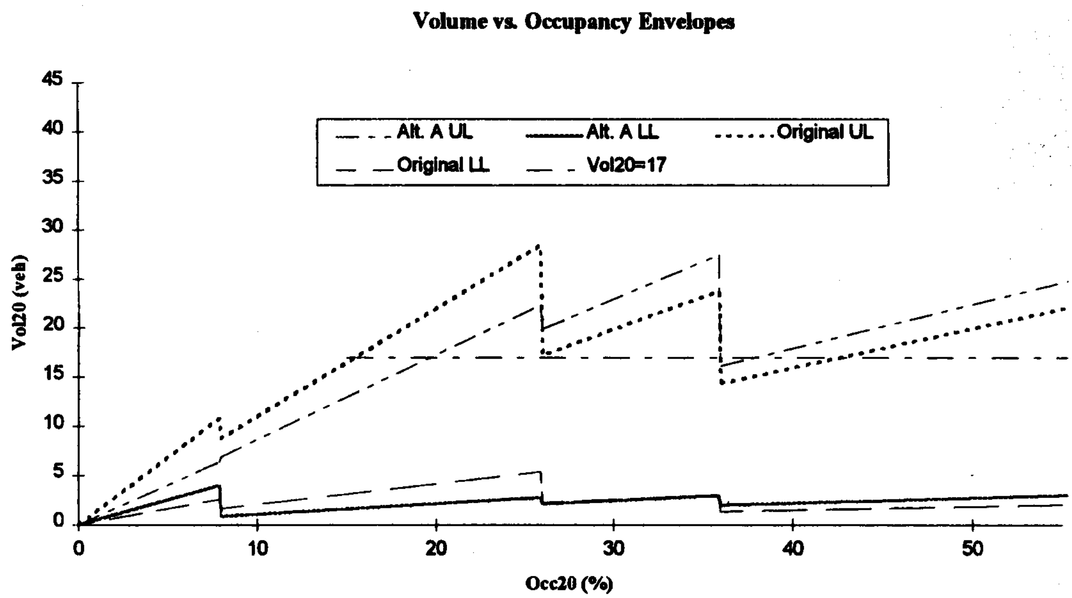
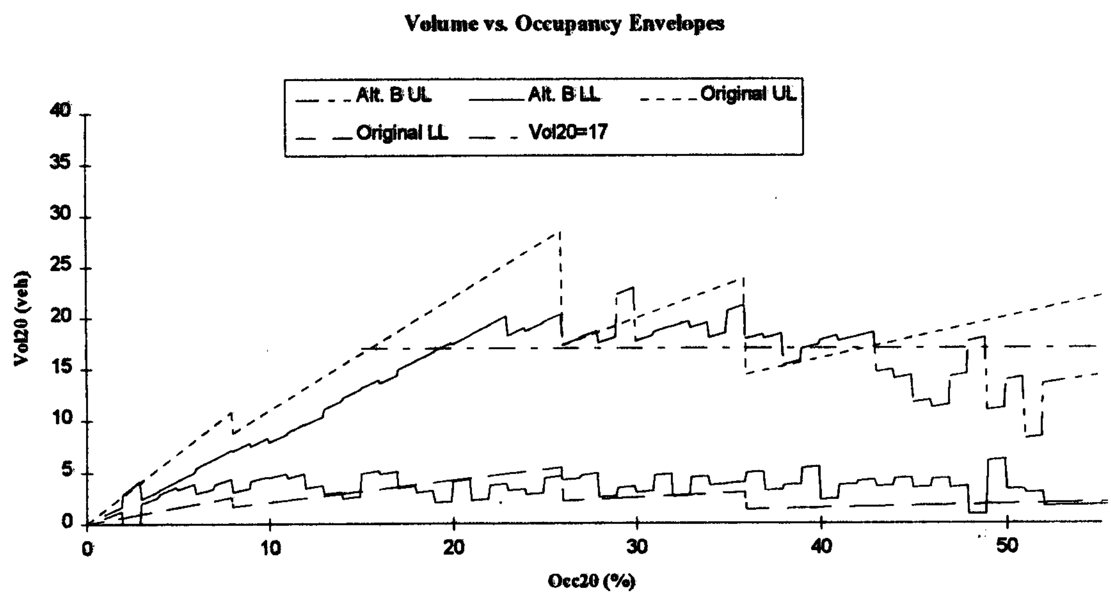


Figure 2 shows that the general shape of the envelopes are the same between the original ones and those of Alternative A. However, one of the major drawbacks of these envelopes, as pointed out by the previous project, is that they cannot capture the variations within the large occupancy ranges.

To resolve this problem, we again used Equations 5a and 5b to calculate the upper and lower limits of the *g*-value for each *one-percent occupancy range* from 1 percent to 52 percent. Because very few data points were available, occupancies above 52 percent were grouped together as three larger ranges. These ranges were 52.0-59.9 percent, 60.0-69.9 percent, and 70.0-99.9 percent. To lower the probability of Type 1 error while still maintaining a reasonable confidence to screen out erroneous data, we chose to calculate the 95 percent confidence limit for the two boundaries. Next, the formulation from the Original NJBD Algorithm was repeated with the new Seattle data to develop the *volume/occupancy* ratios (slopes) for the data screening envelopes (using

Equations 6a and 6b), and the minimum and maximum 20-second volumes for the beginning value of each occupancy range (using Equations 7a and 7b). With these, we developed a new set of *volume/occupancy* (*v/o*) envelopes which we called Alternative B, depicted graphically in Figure 3. Again, the original envelopes are overlaid onto the same figure for comparison.

Figure 3. Modified Loop Data Error Detection Algorithm (Alternative B)



The envelopes given by Alternative B prompt several observations.

1. They are more restrictive than the original envelopes, especially at the two extremes of the occupancy spectrum.
2. The jaggedness is much more prominent for the higher occupancy ranges for the upper limit envelope; the jaggedness is quite serious for the whole lower limit envelope.
3. The shape of the envelopes is closer to the theoretical parabolic volume/density curve.

Smoothed Envelopes

The main problem with the envelopes of Alternative B is their jaggedness. Although we already have more than of 5,500 points, with the majority of the points in the 20 percent to 40 percent range, the envelopes are still jagged. However, such jaggedness is not theoretically reasonable. For example, it is unreasonable that the volume of 12 vehicles per 20-seconds can be permissible when the occupancy is at 48 percent but not at 49 percent, and that this volume again becomes feasible at 50 percent. To eliminate this jaggedness, the researchers fitted a polynomial curve to the upper and lower limit envelopes. The envelopes were fitted with different orders of polynomial curves. The curve-fitting and the regression statistical results are contained in Appendix A and the regression results are summarized in Table 3.

The regressions were done in three stages. The first stage was to fit the upper and lower envelopes with points with occupancies of up to 52 percent. This was done because there were very few points above this occupancy level. The goal of these regressions was to obtain a function with the highest R^2 with no coefficients having a *t*-statistic below 2.0. Given these criteria, the best curves from the first stage of regressions were the second-order curves for both the upper and lower envelopes. However, neither curve could satisfy the boundary condition of going through the origin.

The second stage was to perform the same regressions with a zero-intercept boundary condition. The best curves from this round of regressions were the forth-order curves for both the upper and lower envelopes. However, both curves dropped too fast in the high occupancy range, and both curves became negative before the they reached 100 percent occupancy.

The third stage included the sparse points in the high occupancy range (Occ20 > 52%). This allowed the high end of the envelopes to fit much better and to satisfy the boundary condition. The best curves from this stage of regression were the third-order curve for the upper limit envelope, and the fourth-order curve for the lower envelope. We can see that the R^2 for the lower limit envelope regression is a very low value. This low value is due to significant fluctuations in the *g*-value in the low volume conditions.

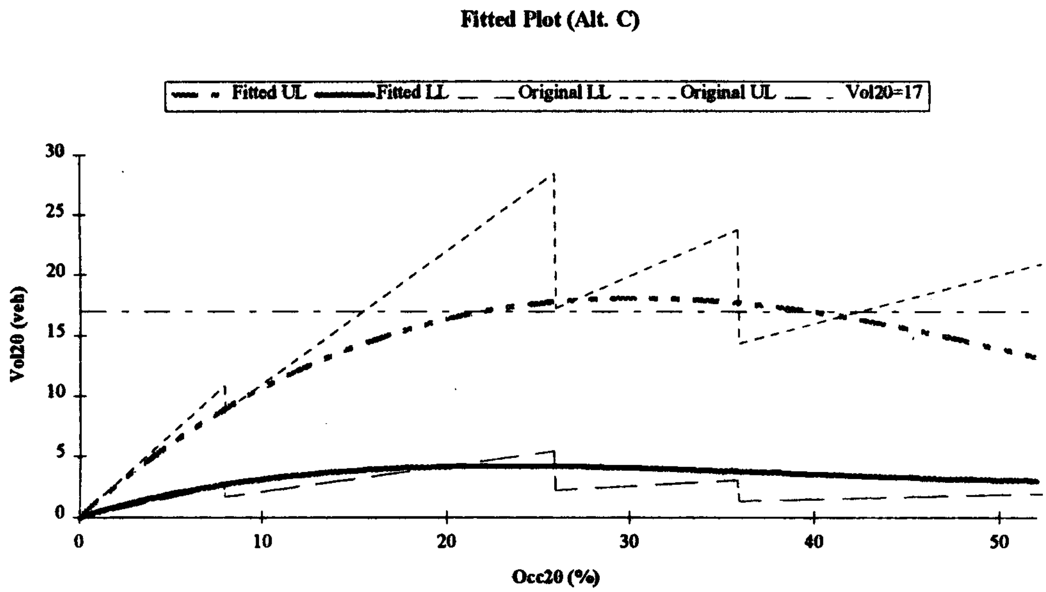
Table 3. Summary of Regression Results

	Upper Limit Envelopes (0-52 percent)		
	Second Order	Third Order	Fourth Order
Adjusted R^2	0.9096	0.9087	N/A
Lowest *t*-stats	-3.294	-0.0466	N/A
	Lower Limit Envelopes (0-52 percent)		
Adjusted R^2	0.1222	0.1370	0.2633
Lowest *t*-stats	-3.3787	1.6467	-0.0918
	Upper Limit Envelopes (0-52 percent): Zero Intercept		
Adjusted R^2	0.8909	0.9056	0.9176
Lowest *t*-stats	-35.3648	-2.8889	3.0305
	Lower Limit Envelopes (0-52 percent): Zero Intercept		
Adjusted R^2	N/A	0.1345	0.2606
Lowest *t*-stats	N/A	6.0042	-5.6722
	Upper Limit Envelopes (0-99.9 percent): Zero Intercept		
Adjusted R^2	0.4595	0.8539	0.8585
Lowest *t*-stats	-16.4746	17.5984	0.0029
	Lower Limit Envelopes (0-99.9 percent): Zero Intercept		
Adjusted R^2	N/A	0.0383	0.1364
Lowest *t*-stats	N/A	8.4266	-3.6317

The third-order polynomial gave the best fit for the upper limit envelope while the fourth-order polynomial gave the best fit for the lower limit envelope (Figure 4a).

We refer to these envelopes as the Proposed Error Detection Algorithm (i.e., the one chosen to replace the Original NJBD Algorithm). Again, the original algorithm is superimposed onto the plot for comparison.

Figure 4a. Proposed Loop Data Error Detection Algorithm (Alternative C) Graphical Representation



The least-square regression equations for the envelopes are as follow:

Upper limit envelope

$$Vol20 = 177.12Occ20^3 - 303.51Occ20^2 + 135.47Occ20 \quad (8)$$

Lower limit envelope

$$Vol20 = -95.47Occ20^4 + 212.21Occ20^3 - 160.12Occ20^2 + 45.09Occ20 \quad (9)$$

where *Vol20* is in vehicles per 20-second time-slice, and *Occ20* is percent occupied time per 20-second time slice in decimals

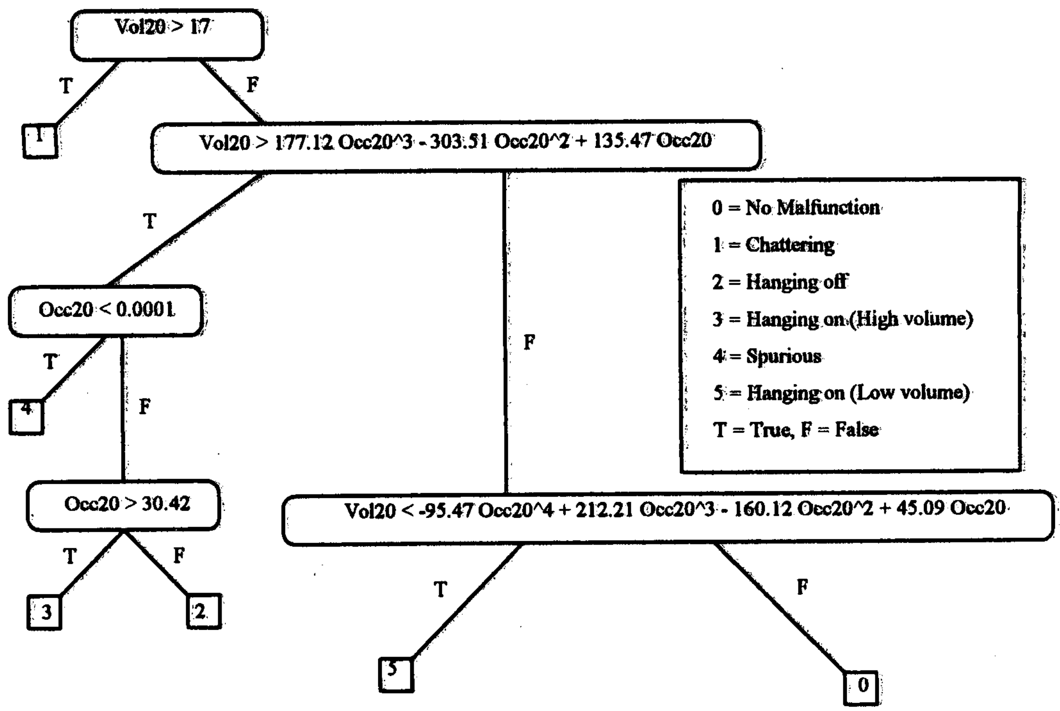
Alternative C (hereinafter called the Proposed Algorithm) has two significant advantages over the rest of the alternatives.

1. Alternative C's curves, or envelopes, are theoretically consistent with our understanding of the parabolic shape of the volume/density curve; Alternative C also eliminates Alternative B's jaggedness problem.
2. Alternative C's envelopes, which are given in simple polynomials, are much easier to program, and they make for faster screening; as such, Alternative C is more efficient for real-time applications. This is important because it was found that the Original NJBD Algorithm developed in the previous project was too cumbersome to be programmed for real-time error flagging. Consequently, only a simplified version of the original algorithm was used at the TSMC. The algorithm currently used by the TSMC is in Appendix B.

When the toothed envelopes are replaced by smoothed ones, the algorithm becomes much simpler. The logical presentation of the Proposed Algorithm is given in Figure 4b.

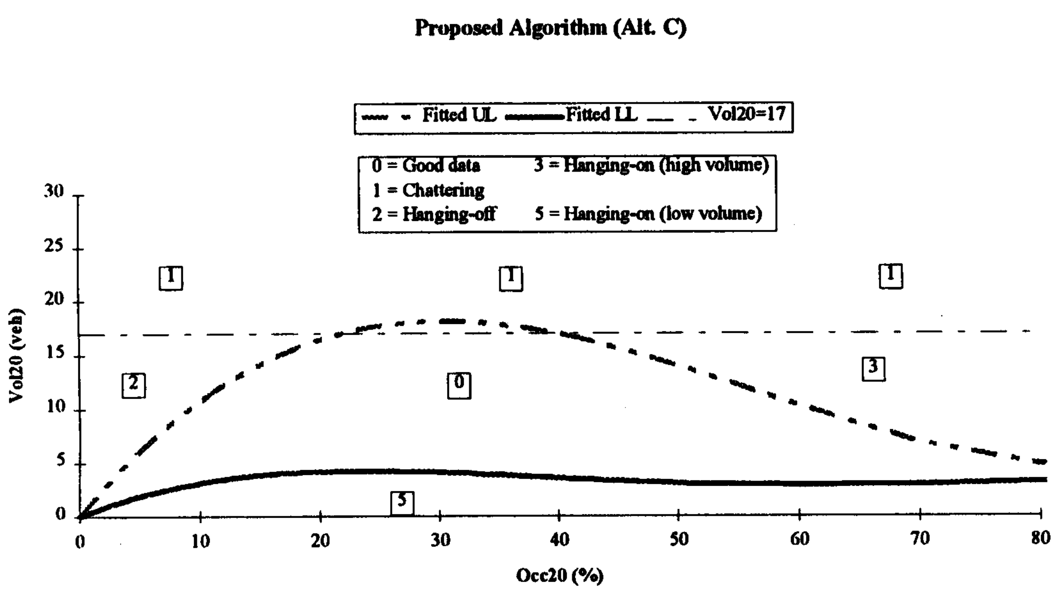
Figure 4b. Proposed Loop Data Error Detection Algorithm (Alternative C)

Logical Representation



It is notable that the interpretations of hanging-on and hanging-off errors of the above algorithm are different from those of the previous project, wherein data falling below the *Vol20* = 17 line and above the upper envelope were considered to be hanging-off errors (Flag 2), and wherein those below the lower envelope were considered to be hanging-on errors (Flag 3). However, as seen in Figure 4a, the envelopes of the Proposed Algorithm are parabolic. The error type changes as one moves from one side of the parabola to the other. That is, when a point is above the upper envelope, it can be either hanging on or hanging off. For example, when a data point is above the left side of the maximum envelope, it means the occupancy is too low for that volume--the result of hanging-off malfunctions (Flag 2). However, if a data point is on the other side of the envelope peak, it means that the occupancy is too high for that volume--the result of hanging-on malfunctions (Flag 3). The hanging-on malfunctions above the upper envelope (Flag 3) are distinguished from those below the lower envelope (Flag 5) by different flag numbers. The volume/occupancy regions that represent reliable data and the various erroneous data flags are shown in Figure 5. This identifies the location of the malfunction, which can be used for possible applications such as incident detection. This matter is discussed in the "Interpretation, Appraisal, and Application" section.

Figure 5. Volume/Occupancy Regions for the Proposed Algorithm



FINDINGS

Data Collection

To evaluate the algorithms, five days worth of 1989 data from six different stations was used. A map showing the locations of these test sites and stations constitutes Figure 6a, and the detector layouts are given in Figures 6b. Figure 7 provides the vertical profiles of these sites. The research team purposely corrupted two of the five days' data with manually-added errors. The three days worth of uncorrupted data, totaling 405 minutes, was used to establish the "normal" pattern of the different detectors. Since 20-second time slices were used, there were 1,215 observations from each detector. Table 4 summarizes the location of the detectors used to collect the control data.

Table 4. Uncorrupted Data Collection

Station	Location	Detectors
228	I-5 @ NE 130th SB	909, 910, 911, 912
229	I-5 @ NE 130th NB	913, 914, 915, 916
214	I-5 @ 244th SW NB	751, 752, 753
225	I-5 @ NE 205th SB	875, 876, 877
226	I-5 @ NE 205th NB	878, 879, 880
283	I-5 @ NE 145th SB	781, 782, 783

Figure 6a. Detector Test Site Locations

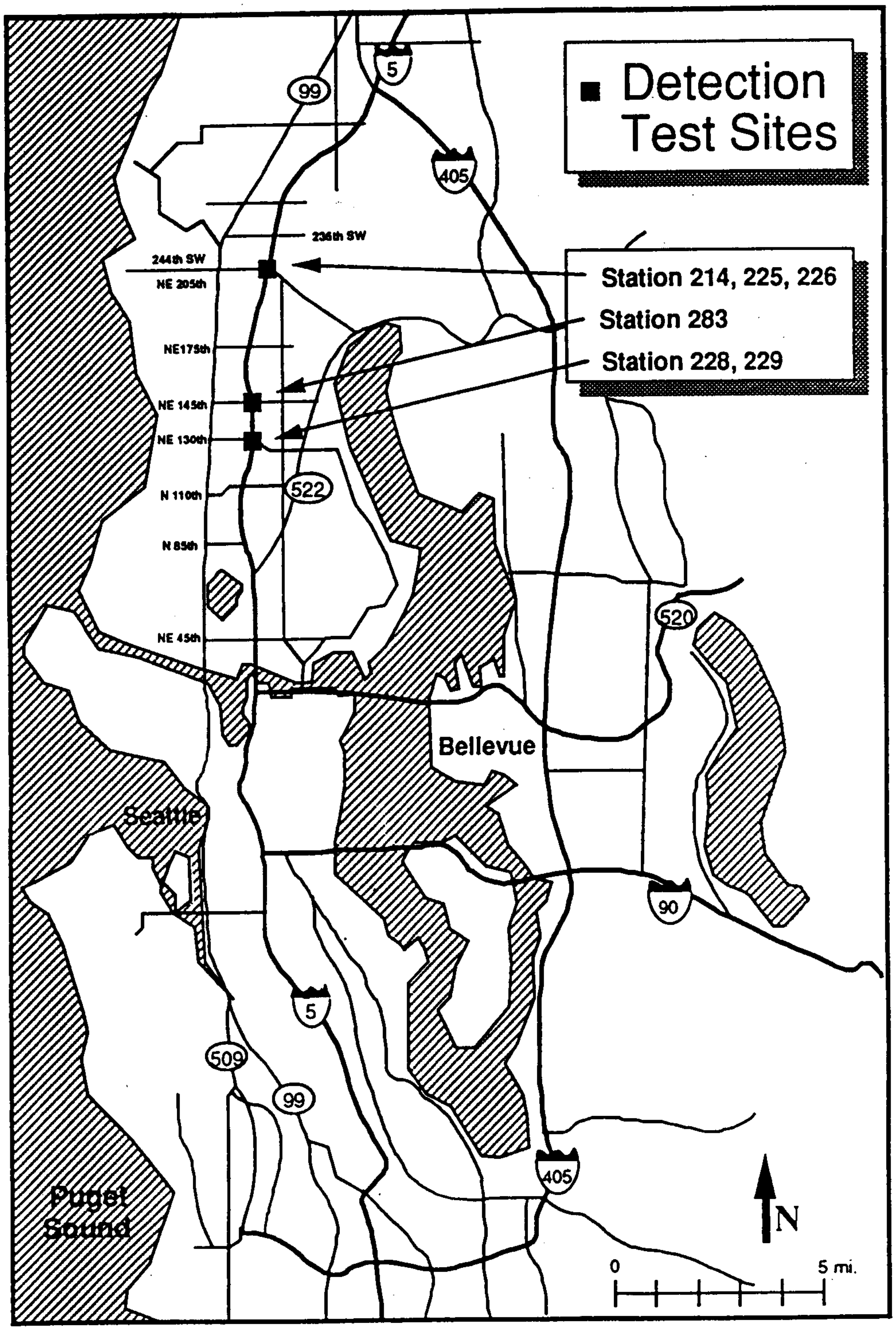


Figure 6b. Detector Layouts

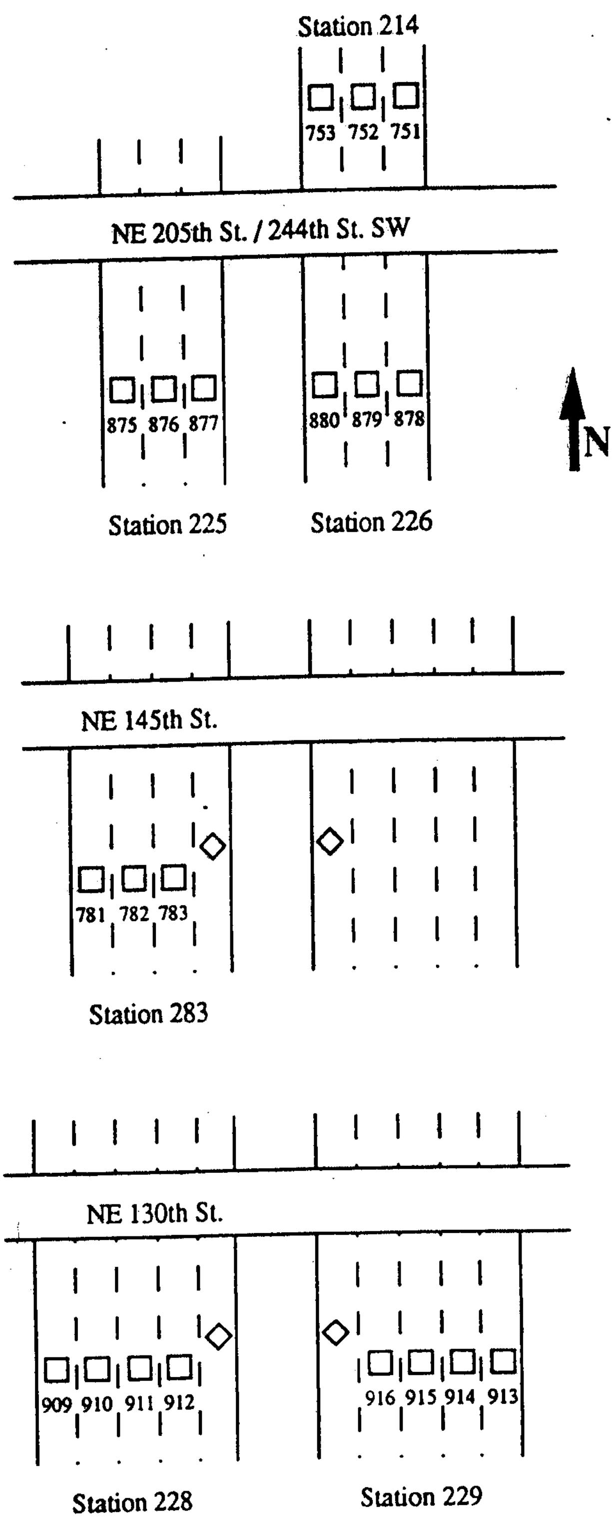
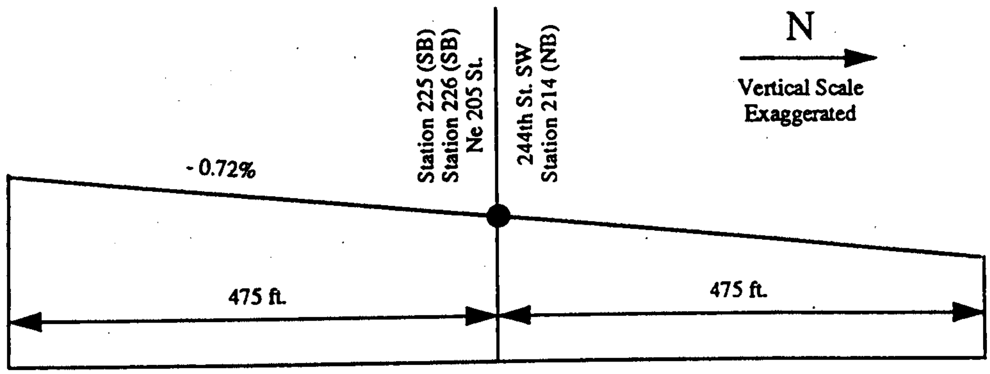
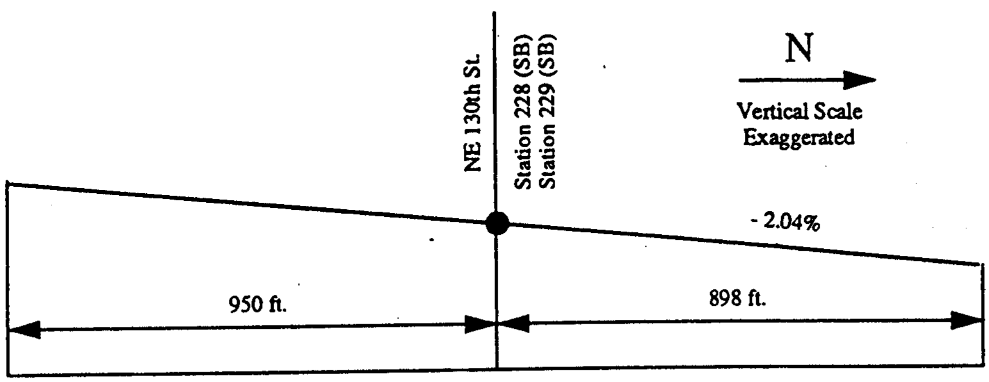


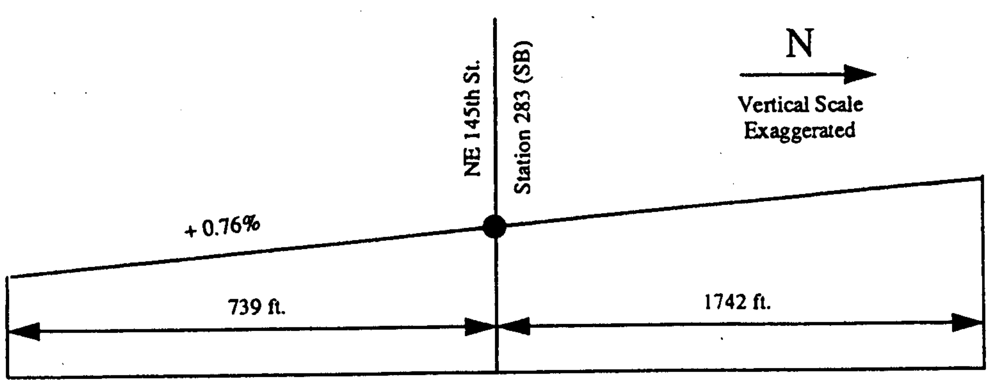
Figure 7. Test Site Vertical Profiles



Interstate 5 at NE 205th St./244th SW St., Seattle, Washington



Interstate 5 at NE 130th Street, Seattle, Washington



Interstate 5 at NE 145th Street, Seattle, Washington

All of these data were first tested by the Original NJBD Error Detection Algorithm to determine their normal pattern with regard to the algorithm. The resulting "normal" patterns of all the test detectors are provided in Table 5. Those detectors that were flagged more than 5 percent of the time (i.e., 61 observations) were eliminated from further algorithm testing because they represented loops with unacceptable error levels prior to the introduction of manually-added errors.

Table 5. Normal Pattern of Detectors

Detector #	Chattering	Hanging off	Hanging on	Spurious pulses
751	0	1	3	0
752	**1**	**59**	**1**	**0**
753	**7**	**193**	**0**	**0**
781	0	13	1	0
782	0	8	0	0
783	**7**	**56**	**0**	**0**
875	0	7	16	0
876	0	1	7	0
877	14	24	1	0
878	0	1	1	0
879	0	5	6	0
880	2	43	3	0
909	0	9	0	0
910	0	8	1	0
911	1	20	0	0
912	**3**	**237**	**0**	**0**
913	0	11	1	0
914	0	1	0	0
915	0	3	0	0
916	8	43	1	0

Table 5 reveals that four of the 20 detectors were discarded under this criterion: detectors 752, 753, 783, 912 (listed in boldface). Therefore, 16 loop detectors from six different stations were ultimately used for the algorithm testing. These stations represented different lane configurations and grades, including three- and four-lane sections, up- and downhill grades, and median, center, and shoulder lanes.

AUTOSCOPE™ ACCURACY

Although the literature already contains many documentations of Autoscope™ system accuracy, we did some further tests to verify the device's accuracy. Specifically, we checked the Autoscope™ results (1) against itself, and (2) against manual counts. We checked Autoscope™ against itself for internal consistency, and we tested it against manual counts for accuracy.

To check consistency, consecutive detectors were set up at 236th St. SW on I-5 on each lane when data were collected. Data gathered by each detector were checked against those from the consecutive detector. Approximately 12 hours of one-minute data, collected over three days, were used for this check. To account for lane changes between the two sets of detectors, the sums of volumes from each set of detectors across all three lanes of the freeway section were used for comparison. Furthermore, since there was a small distance between the two sets of detectors, the one-minute periods could end right after the first set of detectors had been actuated by vehicle passage. Therefore, a difference of ± 2 vehicles was allowed for each lane. After accounting for the differences due to lane changes and time period changes, 36 out of the 682 one-minute observations (5.28 percent) were considered different from one another. However, the sum of volumes for the two sets of detectors in the 12 hours of data collection were only 0.60 percent different from one another.

A program called TDIP (Traffic Data Input Program) was used to check the Autoscope™ count against manual counts. TDIP was developed in the course of a TransNow project at the University of Idaho that explored intersection traffic data collection (Kyte, 1990). Three half-hour checks, one for each of the three days, were carried out. All of the manual counts were done on the center lane of this three-lane freeway section. These counts were compared to Autoscope™ counts from both detectors on that lane. The Autoscope™ system time was synchronized to the TDIP computer manually; as such, the time difference between the two could range from a fraction of a second to one second. In addition, the reaction time during the manual count could amount to another second's difference. Consequently, to account for the reaction time and synchronization differences, a ±2 difference was allowed between the manual and Autoscope™ counts. Although we are taking this manual count as the "true" count, it should be noted that the possibility of human error due to reaction times and fatigue cannot be ignored. Therefore, a third condition was used to minimize human error: the entry must also be caught as an error from the above consistency test to be counted as erroneous. Under these conditions, 13 of the 85 one-minute periods (7.06 percent) failed this test. However, the total count of these 85 minutes was only 1.12 percent and 0.50 percent different from the counts of the two Autoscope™ detectors respectively. This finding is consistent with the Autoscope™ developer's claim of an accuracy level of 92.18 percent to 98.32 percent for volume counts (Michalopoulos, Wolf, and Benke, 1990).

ALGORITHM TESTING

As mentioned earlier, the "normal" patterns of the various detectors were established using uncorrupted data. The researchers then introduced erroneous data to the selected detectors manually. Five actions were taken to simulate erroneous data:

1. Changing the amplifier from presence to pulse mode. During normal operation, the amplifier is in presence mode; the signal stays on as long as the vehicle is sensed by the detector. When the amplifier is changed to pulse mode, each vehicle detection causes the detector to send a short pulse signal to the amplifier. Thus, the vehicle counts are accurate, while the occupancy observations are inaccurately low. This simulates the hanging-off error.
2. Manual hits at a high rate. The purpose is to enter more than 17 hits every 20 seconds. As explained earlier, this rate translates to 3060 vphpl, which is impossible on urban freeways. This action simulates the chattering error.
3. Manual long hits. This action simulates hanging-on errors.
4. Increase detector sensitivity. This simulates hanging-on errors. When the detector is very sensitive, it will sense the vehicle earlier and will continue to be on longer after the vehicle has passed over it.
5. Decrease detector sensitivity. This simulates hanging-off errors. When detector sensitivity is low, the on signal of each detection will be shorter. This gives an accurate count but a lower occupancy--characteristic of the hanging-off error.

The original records of these manual actuations are provided in full in Appendix C, and they are summarized in Table 6.

Table 6. Corrupted Data Collection

Manual Action	Expected Error	Detectors	# of Observations
Change from presence to pulse mode	Hanging off or short pulses (Flag 2)	916, 915, 914, 913, 911, 910, 909, 880, 879, 877, 876, 875, 782, 781, 751	425
Many actuations (>17 in 20 sec.)	Chattering (Flag 1)	910, 879, 877, 875, 781	52
Long actuations	Hanging on (Flag 3)	910, 879, 877, 781, 751	94
Increase sensitivity	Hanging on (Flag 3)	916, 915, 914, 911, 879, 878	177
Decrease sensitivity	Hanging off (Flag 2)	915, 914, 911, 910, 880, 878, 877, 876, 875, 782	362

With the above test data set, we tested both the Original NJBD Algorithm and the new Proposed Algorithm for usefulness and reliability. The previous project had employed a persistent criterion to avoid too many false positive flags (i.e., a data point is counted as erroneous only if two of three 20-second observations within a moving one-minute period are considered to be erroneous). However, we did not use the persistent criterion for our tests here; we wanted the algorithm to catch intermittent malfunctions. The test results are given in chronological order in Appendix D. Table 7 summarizes these results, which are sorted according to the actions taken to corrupt the data, and accordingly, the expected flag number. The number of 20-second periods corrupted is listed in the column entitled "Corrupted Periods"; the next column "New Alg Flag," lists the number of these periods flagged by the New (Proposed) algorithm; and the next column, entitled "Old Alg Flag," lists the number of these periods flagged by the Old (Original) algorithm.

Table 7. Summary of Test Results

Location	Grade	Lane type	Date	Det #	Time	Action	Expected Flag #	Corrupted Periods	New Alg Flag	Old Alg Flag	% Flagged by New	% Flagged by Old	Difference
244 SW NB	2.86	shoulder	9/13	751	15:36	Long hits	3 or 5	12	2	0	16.67 %	0.00 %	16.67 %
NE 145 SB	-0.76	shoulder	9/13	781	16:17	Long hits	3 or 5	12	6	2	50.00 %	16.67 %	33.33 %
NE 205 SB	0.72	median	9/13	877	15:57	Long hits	3 or 5	14	0	0	0.00 %	0.00 %	0.00 %
NE 205 NB	-0.72	center	9/13	879	15:57	Long hits	3 or 5	12	12	0	100.00 %	0.00 %	100.00 %
NE 130 SB	2.04	center right	9/12	910	15:16	Long hits	3 or 5	32	8	6	25.00 %	18.75 %	6.25 %
NE 130 SB	2.04	center right	9/13	910	9:16	Long hits	3 or 5	12	1	1	8.33 %	8.33 %	0.00 %
244 SW NB	2.86	shoulder	9/12	751	9:16	Pulse mode	2	21	14	14	66.67 %	66.67 %	0.00 %
244 SW NB	2.86	shoulder	9/12	751	15:56	Pulse mode	2	14	14	14	100.00 %	100.00 %	0.00 %
NE 145 SB	-0.76	shoulder	9/12	781	15:37	Pulse mode	2	24	24	24	100.00 %	100.00 %	0.00 %
NE 145 SB	-0.76	center	9/13	782	16:17	Pulse mode	2	27	27	27	100.00 %	100.00 %	0.00 %
NE 205 SB	0.72	shoulder	9/13	875	15:57	Pulse mode	2	28	27	27	96.43 %	96.43 %	0.00 %
NE 205 SB	0.72	center	9/12	876	16:17	Pulse mode	2	30	30	28	100.00 %	93.33 %	6.67 %
NE 205 SB	0.72	median	9/13	877	8:57	Pulse mode	2	13	13	12	100.00 %	92.31 %	7.69 %
NE 205 NB	-0.72	center	9/12	879	16:17	Pulse mode	2	30	30	30	100.00 %	100.00 %	0.00 %
NE 205 NB	-0.72	median	9/13	880	8:57	Pulse mode	2	11	11	11	100.00 %	100.00 %	0.00 %
NE 130 SB	2.04	shoulder	9/12	909	8:55	Pulse mode	2	27	27	27	100.00 %	100.00 %	0.00 %
NE 130 SB	2.04	center right	9/13	910	15:16	Pulse mode	2	29	29	28	100.00 %	96.55 %	3.45 %
NE 130 SB	2.04	center left	9/12	911	15:16	Pulse mode	2	29	29	29	100.00 %	100.00 %	0.00 %
NE 130 SB	2.04	center left	9/13	911	9:16	Pulse mode	2	28	28	28	100.00 %	100.00 %	0.00 %
NE 130 NB	-2.04	shoulder	9/12	913	8:55	Pulse mode	2	27	3	2	11.11 %	7.41 %	3.70 %
NE 130 NB	-2.04	shoulder	9/12	913	15:16	Pulse mode	2	29	29	28	100.00 %	96.55 %	3.45 %
NE 130 NB	-2.04	center left	9/13	915	9:16	Pulse mode	2	28	28	28	100.00 %	100.00 %	0.00 %
NE 130 NB	-2.04	median	9/13	916	15:16	Pulse mode	2	30	30	29	100.00 %	96.67 %	3.33 %
NE 145 SB	-0.76	center	9/12	782	15:37	Sens to (1)	2	18	5	2	27.78 %	11.11 %	16.67 %
NE 205 SB	0.72	shoulder	9/13	875	8:57	Sens to (1)	2	15	0	0	0.00 %	0.00 %	0.00 %
NE 205 SB	0.72	center	9/13	876	15:57	Sens to (1)	2	30	3	0	10.00 %	0.00 %	10.00 %
NE 205 SB	0.72	median	9/12	877	16:17	Sens to (1)	2	30	12	8	40.00 %	26.67 %	13.33 %
NE 205 NB	-0.72	shoulder	9/12	878	16:17	Sens to (1)	2	32	0	0	0.00 %	0.00 %	0.00 %
NE 205 NB	-0.72	shoulder	9/13	878	8:57	Sens to (1)	2	16	0	0	0.00 %	0.00 %	0.00 %
NE 205 NB	-0.72	median	9/13	880	15:57	Sens to (1)	2	34	13	4	38.24 %	11.76 %	26.47 %
NE 130 SB	2.04	center right	9/12	910	8:55	Sens to (1)	2	33	0	0	0.00 %	0.00 %	0.00 %
NE 130 SB	2.04	center left	9/13	911	15:16	Sens to (1)	2	30	3	2	10.00 %	6.67 %	3.33 %
NE 130 NB	-2.04	center right	9/12	914	15:16	Sens to (1)	2	30	0	0	0.00 %	0.00 %	0.00 %
NE 130 NB	-2.04	center right	9/13	914	9:16	Sens to (1)	2	30	0	0	0.00 %	0.00 %	0.00 %
NE 130 NB	-2.04	center left	9/12	915	8:56	Sens to (1)	2	33	0	0	0.00 %	0.00 %	0.00 %
NE 130 NB	-2.04	center left	9/13	915	15:16	Sens to (1)	2	31	3	0	9.68 %	0.00 %	9.68 %
NE 130 SB	2.04	center left	9/12	911	8:55	Sens to (5)	3 or 5	31	0	0	0.00 %	0.00 %	0.00 %
NE 130 NB	-2.04	center right	9/12	914	8:56	Sens to (5)	3 or 5	28	1	1	3.57 %	3.57 %	0.00 %
NE 205 NB	-0.72	shoulder	9/13	878	15:57	Sens to (6)	3 or 5	31	0	0	0.00 %	0.00 %	0.00 %
NE 205 NB	-0.72	center	9/13	879	8:57	Sens to (6)	3 or 5	14	8	6	57.14 %	42.86 %	14.29 %
NE 130 NB	-2.04	center right	9/13	914	15:16	Sens to (6)	3 or 5	30	0	0	0.00 %	0.00 %	0.00 %
NE 130 NB	-2.04	center left	9/12	915	15:16	Sens to (6)	3 or 5	28	1	0	3.57 %	0.00 %	3.57 %
NE 130 NB	-2.04	median	9/13	916	9:16	Sens to (7)	3 or 5	15	1	1	6.67 %	6.67 %	0.00 %
NE 145 SB	-0.76	shoulder	9/13	781	16:17	Vol20>17	1	10	10	10	100.00 %	100.00 %	0.00 %
NE 205 SB	0.72	shoulder	9/12	875	16:17	Vol20>17	1	8	8	8	100.00 %	100.00 %	0.00 %
NE 205 SB	0.72	median	9/13	877	15:57	Vol20>17	1	12	11	11	91.67 %	91.67 %	0.00 %
NE 205 NB	-0.72	center	9/13	879	15:57	Vol20>17	1	9	9	9	100.00 %	100.00 %	0.00 %
NE 130 SB	2.04	center right	9/13	910	9:16	Vol20>17	1	13	13	13	100.00 %	100.00 %	0.00 %

Original NJBD Algorithm

We found the Original Algorithm to be very effective in detecting the hanging-off (short pulse) malfunction, which was simulated by changing the detector from presence to pulse mode. Of the 425 observations, 386 were detected as erroneous by the algorithm. Out of the 39 misses, 26 were from a single detector, #913. Even including this questionable detector, the false negative rate was only 9.18 percent. If we disregard this one questionable detector, the false negative rate drops to 3.26 percent. These findings tells us that the algorithm is highly effective in screening hanging-off malfunctions.

Chattering was the second type of malfunction tested. The criterion for this error was simply detecting more than 17 vehicles within a 20-second period. This was simulated by rapid manual actuations. Of the 52 observations, 51 were detected. The only instance in which no malfunction flags were given had only 17 actuations within the 20-second period. It is likely that the researcher simply did not make enough hits for this 20-second period. There were no false positives during the entire time the test data were collected. Therefore, we can conclude that the algorithm effectively screens chattering malfunctions. Of course, the reader is reminded that the manually introduced error was purposely set to record > 17 hits. It is still possible to miss chattering that does not result in a high enough volume (Nihan, 1994).

The algorithm was unsuccessful in detecting hanging-on (long pulse) malfunctions. This malfunction was simulated by the researcher making long manual hits. The original algorithm flagged only nine of 94 simulated periods. The high occupancy and low volume conditions were treated as congested conditions and were not screened out as erroneous data. Although there were no false positives for this test, the success rate for this flag was too low to be of much practical use.

The algorithm was unsuccessful in dealing with the last two adjustments made by the researchers to corrupt the data. These adjustments were made to the sensitivity of the detector amplifiers. Only 4.42 percent of the decreased sensitivity observations and 4.52 percent of the increased sensitivity observations were flagged as erroneous. However, as explained in the previous project, the actual impact of decreasing the sensitivity from two to one (on a scale of one to seven) is questionable. By the same token, increasing the sensitivity of the detectors from two to seven caused the occupancies to increase. However, this was mistaken as congested data rather then erroneous data.

This comprehensive evaluation of the original algorithm with an extensive data set proved useful in pointing out the algorithm's strengths and weaknesses. It not only substantiated the previous project's preliminary findings; but it also provided a better database with which to conclude the effectiveness of the algorithm in screening chattering data.

Proposed Algorithm

The research team used the same test data set to evaluate the original algorithm and to test the improved error detection algorithm; this made it possible to compare the results of each. The testing produced the following results:

1. The first set of simulated data introduced hanging-off errors by changing the detector mode from presence to pulse. Given the Original Algorithm's relatively high

detection rate (386 out of 425), the Proposed Algorithm still improved performance by seven more detections, a 1.65 percent improvement (393 detections out of 425). Again, one detector (#913) accounted for 24 of the 32 misses. If we disregard this questionable detector, we have only eight misses, out of the 401 periods (2.00 percent). Although this is not a very significant improvement, it does represent progress from an already highly effective rate to one that is nearly perfect.

The researchers expected that this more sensitive algorithm would render a higher false positive rate, and they were correct. Of the 345 uncorrupted periods over the two test days, seven were flagged as erroneous. This represents a 2.03 percent false positive rate. Although this is a substantial increase over the existing 0.87 percent rate, it is still tolerable, even if they were actually false positives. Since we have chosen to regard detectors flagged no more than 5 percent of the time as normal operation, the 2.03 percent is acceptable.

2. The second type of malfunction is chattering. The screening criterion for this malfunction remained unchanged from the previous algorithm because it was already very effective for the type of error that was manually introduced. Therefore, the results were the same as before.

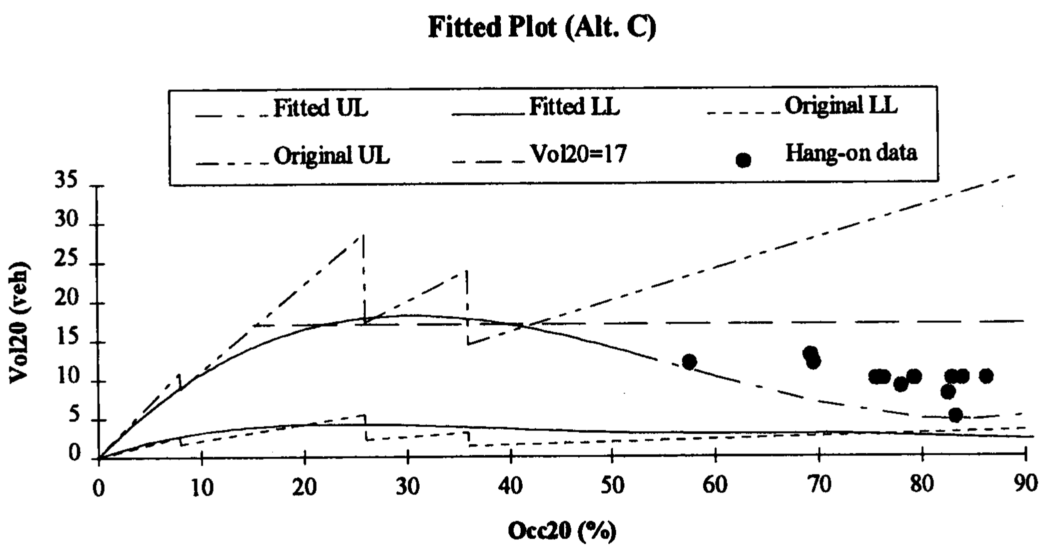
3. The third type of malfunction is hang-on signals or long pulses. The previous algorithm was most ineffective in detecting hanging-on malfunctions. The new algorithm represents a significant improvement in screening effectiveness for this type of error. Twenty-nine of the 94 simulated malfunction periods were detected as erroneous. This provides a significant (322.22 percent) improvement over the original algorithm. The major improvement lies in the detection of the high-volume,

high-occupancy points that the original algorithm missed entirely. This is due to the fact that the new algorithm has envelopes that better reflect the volume-occupancy relationships in the congested region. Figure 8 illustrates an example of the simulated hanging-on data from Detector 879. These erroneous data were simulated by long manual actuations. As shown in Figure 8, the points that are flagged by the new algorithm were all missed by the old algorithm. It could be noted that the Proposed Algorithm offers the most outstanding improvement over the Original NJBD Algorithm in screening out this type of error. However, the effectiveness of the screening for hanging-on errors is still quite low, even under the much improved algorithm. The graphical plots of all six test periods of hanging-on simulations are included in Appendix E. We can see that, except for Detector 879 where all the points were screened out by the algorithm, most of the long-hits gave points that were still inside the reliable data region. Although all of these points might have been hanging-on errors, the occupancies were not high enough to be screened out. This is to say that when traffic is light, the hanging on of detectors will only be interpreted as more congested traffic. This kind of condition may never be detected by any algorithms that rely on feasible data regions. On the other hand, when the traffic is already heavy, the Proposed Algorithm may be very useful in catching the detector hanging-on malfunction. This implication is important because our past experience and the literature both indicate that detector malfunctions are most frequently found during congested traffic conditions. There are no false positives for this test.

4. As suggested by the evaluation of the original algorithm, the adjustments made to the sensitivity of the detector amplifiers to corrupt the data were unsuccessful. Although

the new algorithm's higher sensitivity resulted in a slightly higher rate of erroneous data detection, only 10.50 percent of the decreased sensitivity observations and 5.88 percent of the increased sensitivity observations were flagged as erroneous. The effectiveness of changing sensitivity to corrupt the data is still questionable.

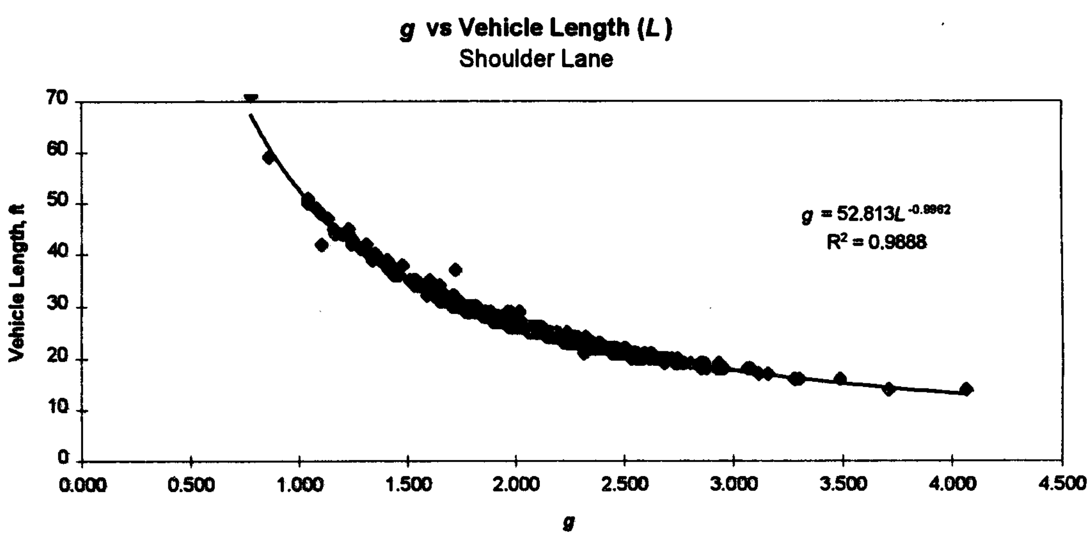
Figure 8. Simulated Hanging-on Errors (Detector #879)



UNDERSTANDING OF TRAFFIC FLOW PARAMETERS

As noted in the development process of the error detection algorithm, there were some variations in the traffic flow that were not explicable in terms of the volume, occupancy, and speed parameters. That is why, even with a huge database, the resulting data region envelopes were still very jagged. An investigation of the relationships of the *g*-value with different variables revealed that the *g*-value is highly correlated with vehicle lengths of the traffic stream. Insofar as the Autoscope™ data collection system could provide the length of each vehicle, the research team carried out a preliminary study of the relationship between average vehicle length per 20-second time-slice and the g-value. When the data were plotted graphically, they fell closely to a curve. Data from different days and from different lane types (median, center, and shoulder) all formed almost identical curves. An example of these plots is shown in Figure 9. Appendix F contains other plots.

Figure 9. A Fitted Plot of g vs. Vehicle Length (L)



Comparing Equations 1 and 3, the relationship between density and lane occupancy is given by the conversion factor g which is given by

$$g = \frac{1}{100} \times \frac{5280}{\overline{L}_e} = \frac{52.8}{\overline{L}_e} \tag{10}$$

where g and $\overline{L}_e$ are as defined before

Since the Autoscope™ detector is only a line on the screen with zero length, the effective length of a vehicle is the actual vehicle length. Therefore, Equation 10 becomes,

$$g = 52.8 \times \bar{L}^{-1} \tag{11}$$

Therefore, this was the functional form we have used to perform regression analysis, i.e.,

$$g = a \times \bar{L}^{-b} \tag{12}$$

wherein a and b are the regressed parameters

The results of these regressions are summarized below in Table 8. The very high adjusted R^2's of the regression equation confirmed the strong relationship between the two parameters. Some statistical analyses are still being done to investigate whether the regressed parameters are in fact statistically equivalent to the theoretical values given in Equation 11.

The implication of this relationship could be very useful. Because vehicle classification, and hence average vehicle length, is a parameter wherein data can be collected for different sites, facilities, or lane types, we can potentially estimate other traffic flow parameters such as density and speed with a known g vs. average vehicle length $(\bar{L})$ relationship. That is, if we can express g as a function of average vehicle length,

$$g = f(\bar{L} \tag{13}$$

then we can substitute this relationship into Equation 2 to derive density.

$$k = g \times o = f(\bar{L}) \times o \tag{14}$$

We can then substitute this into Equation 1 and estimate speed.

$$u = \frac{q}{k} = \frac{q}{f(\bar{L}) \times o} \tag{15}$$

Since both volume and occupancy can be collected from the current single-loop detectors, the above formulation can serve as a quick-and-dirty means of estimating speed. Therefore, the above proposed relationship is worthy of further investigation.

Currently, the WSDOT collects and reports vehicle classification data of the state highways once every two years. Although the fluctuation of traffic mixes over time might render these data invalid for use in the formulation here, other project-specific classification data collected at different sites might be used to test the validity of estimating g with vehicle length.

Table 8. Summary of Vehicle Length vs. *g*-Value Regression Results

$g = a \times \overline{L}^{-b}$				
Data Set #	Lane Type	*a*	*b*	Adjusted R^2
1	Median	49.440	0.9115	0.9590
1	Center	52.121	0.9810	0.9829
1	Shoulder	52.813	0.9962	0.9888
2	Median	51.445	0.9607	0.9778
2	Center	51.784	0.9668	0.9799
2	Shoulder	52.335	0.9845	0.9854
2	Median	52.208	0.9791	0.9844
2	Center	51.464	0.9498	0.9737
2	Shoulder	52.243	0.9798	0.9854

INTERPRETATION, APPRAISAL, AND APPLICATION

ERRONEOUS DATA DETECTION

From the above testing section, we can see a marked improvement of the Proposed Algorithm over the Original NJBD Algorithm, especially in screening out the hanging-on errors that occur in congested conditions.

Because this algorithm is to be used on-line with real-time data, the algorithm's simplicity plays an important role in its usefulness. The Original NJBD Algorithm has a total of 14 logical decision points; an average data point would need to go through a minimum of three, and a maximum of seven decision points. This is why the TSMC currently uses a simplified version of the algorithm. The Proposed Algorithm has a total of five decision points; an average data point would need to go through three to four decision points. Furthermore, the Proposed Algorithm only needs to use one variable, namely occupancy, for its calculation, compared to the two-variable calculation (volume/occupancy) required by the Original NJBD Algorithm. These improvements in the structure of the algorithm should make it much quicker and more useful for real-time application.

Since the new algorithm was developed with the data collected from mainline traffic, it is only valid for mainline loop detector data screening. Other facilities, such as HOV lanes, which have traffic flow patterns quite different from those of the mainline, were not tested in this project.

Therefore, this means that there are two implications for the application of the results of this project. The first implication is the implementation of the Proposed

Algorithm in the Seattle freeway system at the TSMC. Although the algorithm was developed with data from the station at 236th SW on I-5, it has been tested on six different sites characterized by varied geometric and lane configuration. The data used to develop and calibrate the new algorithm were from all three lanes of the station at 236th SW. Hence, the Proposed Algorithm was developed with the data of an "average" lane. Since the test results showed that the algorithm's effectiveness does not vary according to lane type and configuration, we are reasonably confident that the Proposed Algorithm is applicable to different parts of the Seattle system.

It should also be pointed out that, except for chattering data and spurious pulses (which are treated as erroneous data), the other error flags should be treated as suspect data. The area enclosed by the envelopes represents a feasible region for "normal" traffic flow data. When a point falls outside this feasible region, it can denote either (1) a detector malfunction, or (2) the existence of some "abnormal" traffic pattern, such as that caused by an incident.

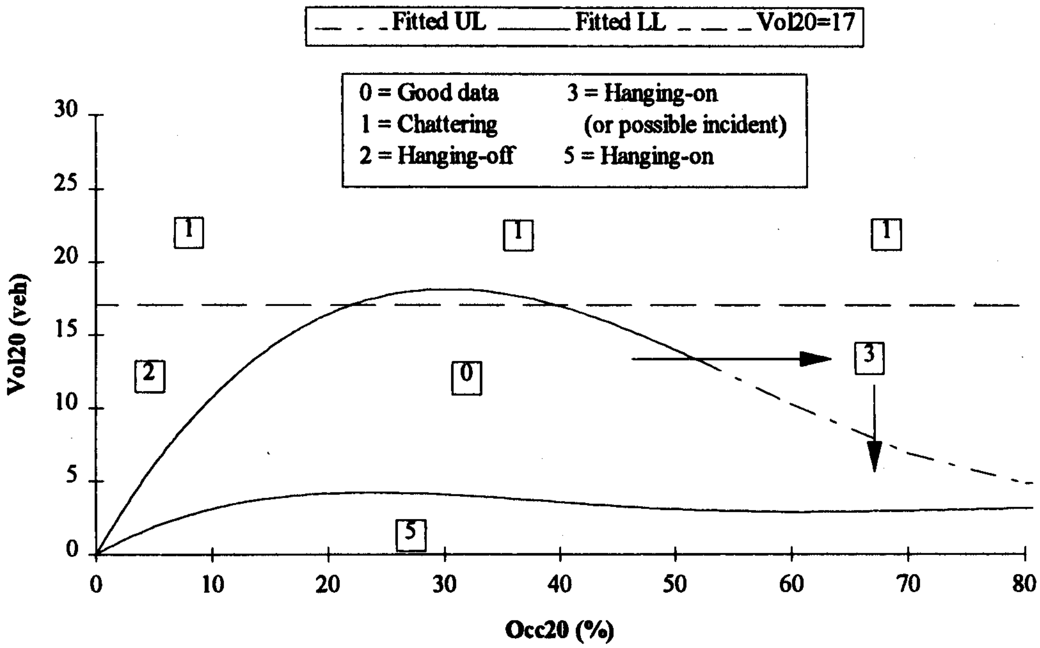
The second implication deals with the application of Autoscope™ video imaging technology. This technology could be used to collect site- or facility-specific data and to apply the methodology described herein to calibrate error detection algorithms for different facilities. This can apply to facilities such as HOV lanes, whose traffic flow patterns are quite different from those of the mainline. The Autoscope™ system is also applicable to control purposes since it has been shown not only to provide reasonably accurate volume and occupancy data, but also to give speed data which is not available from single-loop detectors used most widely for control purposes.

INCIDENT DETECTION

A third possible application of this algorithm involves incident detection. Persaud et al. (1990) divided the volume/occupancy plot into three areas identified as uncongested and congested regions. They attempted to identify incidents by the manner in which traffic moves from one area to another. A similar concept is applied here. Because incidents usually create rapid changes in the traffic flow pattern, the transitional state from one flow pattern to another can generate data that stray beyond the "normal" or "good" data envelopes. This is especially true in the case of moderately heavy to heavy traffic, wherein volume is high and flow is still steady. An incident can put a sudden constriction to the flow passage, thus compressing the upstream flow. This high-volume, high-occupancy transitional condition will be flagged as an error with Flag 3, before the traffic slows down and moves back to the "good" data region, characterized by lower volumes and high occupancy. This transition is depicted by means of the arrows in Figure 10. Quick recognition of the erroneous data's location is thus desirable. This is why the erroneous data flags for different areas of the volume/occupancy plot are labeled separately. However, since this particular function has not been tested in this project, it may be an issue worthy of future investigation.

Figure 10. Transitional Condition due to An Incident

Proposed Algorithm (Alt. C)



CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The new algorithm developed as a result of this project is based on data collected locally, that is, in the Seattle metropolitan area. A substantial percentage of the data used for calibration was collected in congested conditions, which provides a better understanding of traffic flow patterns of congested conditions; hence, the development of a better data error screening algorithm to deal with hanging-on errors.

The testing of the new algorithm showed that it is very effective (almost 100 percent) in screening out hanging-off errors, chattering data, and spurious pulses. The new algorithm also improved the ability to screen out hanging-on errors substantially, although the effectiveness of hanging-on detections could be further improved. The new algorithm has very low false positive rates overall. The findings of the algorithm testing also raised incident detection implications.

RECOMMENDATIONS

The results from this project suggest several recommendations. First, the new error detection algorithm can be implemented in the WSDOT control system in the Seattle I-5 corridor. Given that this freeway section is very congested during peak periods, the improvement in the detection of hanging-on errors provided by the new algorithm is a much needed one.

Second, insofar as the algorithm is somewhat location/facility specific, video data should be collected from locations/facilities for the development of error detection algorithms specific to those facilities such as HOV lanes. Since the Autoscope™ system has already been purchased for this project, this would be an inexpensive undertaking that could further improve the WSDOT surveillance and control system's error detection capability.

In the algorithm development process, it was noted that fluctuation of the *g*-values was very great, especially as occupancy values rose. Investigation of the relationships of the *g*-value to different variables reveals that the *g*-value was highly correlated with vehicle lengths of the traffic stream. This helps explain why roadway grades affect the *g*-value: grades have different effects on vehicle performance, depending on vehicle lengths. A preliminary study indicated that vehicle length might be the most important variable that directly relates to the fluctuation of the *g*-value. For 20-second averages, the relationship is almost identical to that expected theoretically (see Equation 11). However, the fluctuation of vehicle lengths will not be as prominent when vehicle length observations are averaged over longer time periods; hence the relationship between average vehicle length and *g*-value could be different. Therefore, the last recommendation is that this relationship be studied further. If we can better understand this relationship, we might be able to use traffic-mix characteristics (such as percentages in different vehicle classifications), which are easily observable, to calculate the *g*-value, and hence calculate density and speed variables. Moreover, at the locations where the traffic mixes are known from recent collection efforts, the WSDOT can calculate the average effective vehicle lengths for specific stations to estimate density and thus speed with Equations 3, and 1 respectively.

IMPLEMENTATION

Proposed Error Detection Algorithm

Because real-time volume and occupancy data are already on-line for the TSMC control systems, the same data can also be used for the Proposed Error Detection Algorithm, which can be programmed at the mainframe computer (the VAX computer at WSDOT) as a small subroutine to replace the current TSMC error flags. This new algorithm can be applied to all the mainline detectors in the Seattle section of I-5.

Autoscope™ System Application

The WSDOT's TSMC can access and control surveillance cameras along I-5 in the Seattle metropolitan area. For algorithm development and for calibration of other facilities, such as HOV lanes, traffic flows on I-5 can be recorded with a VCR at the TSMC connected to these cameras. Traffic videos depicting various congestion levels should be collected to better fine tune the error detection envelopes. At least three typical weekdays should be used, each covering traffic from before, during, and after the daily peak. The Autoscope™ video imaging system and the custom software can then analyze these video tapes to obtain 20-second volume, occupancy, and speed data.

The data provided by the Autoscope™ analysis can be used to calculate *g*-values, and error detection algorithms can be calibrated by means of the methodology described herein. Thus, new algorithms can be readily calibrated for different facilities.

Autoscope™ application in the TSMC control system will also enhance the capability, reliability, and accuracy of data collection. Because communications hardware is already in place for the I-5 corridor, Autoscope™ systems can easily be connected to the cameras in the field for real-time data collection, analysis, and traffic control. However, since cameras must be at fixed positions and angles, current surveillance cameras might not be useful for this purpose. It would be particularly appropriate to set up a temporary camera hooked up to an Autoscope™ system to provide traffic control at construction sites, where detection loop operations are usually interrupted.

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Appendix A Envelope Regression Results

Regression Statistics of Upper Bound (2nd Order)						
Multiple R	0.954663995					
R Square	0.911383343					
Adjusted R Square	0.90961101					
Standard Error	1.624505976					
Observations	103					
Analysis of Variance						
	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*	
Regression	2	2714.115656	1357.057828	514.228009	2.37557E-53	
Residual	100	263.9019666	2.639019666			
Total	102	2978.017623				
	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.70052999	0.516247588	-3.294020223	0.00135845	-2.724750619	-0.67630937
Occ	1.329965634	0.044537009	29.86203329	3.1426E-52	1.241605467	1.4183258
Occ^2	-0.02116896	0.000809526	-26.14983206	5.0519E-47	-0.022775039	-0.01956289

Regression Statistics of Upper Bound (3rd Order)						
Multiple R	0.954665013					
R Square	0.911385287					
Adjusted R Square	0.908699993					
Standard Error	1.632672028					
Observations	103					
Analysis of Variance						
	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*	
Regression	3	2714.121446	904.7071485	339.398655	6.09303E-52	
Residual	99	263.8961772	2.665617951			
Total	102	2978.017623				
	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.67620305	0.735990468	-2.277479295	0.0248444	-3.136568074	-0.21583803
Occ	1.324920949	0.11713678	11.31088753	1.0405E-19	1.092496122	1.557345775
Occ^2	-0.02093661	0.005051654	-4.144506119	7.0466E-05	-0.030960192	-0.01091303
Occ^3	-2.9027E-06	6.22842E-05	-0.046603315	0.96292051	-0.000126488	0.000120683

Regression Statistics of Lower Bound (2nd Order)						
Multiple R	0.373407689					
R Square	0.139433302					
Adjusted R Square	0.122221968					
Standard Error	1.077002653					
Observations	103					
Analysis of Variance						
	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*	
Regression	2	18.79383989	9.396919947	8.10124899	0.000548563	
Residual	100	115.9934715	1.159934715			
Total	102	134.7873114				
	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	2.219378957	0.342257911	6.484522011	3.228E-09	1.540348933	2.898408981
Occ	0.112420975	0.029526808	3.807420495	0.00023996	0.053840622	0.171001328
Occ^2	-0.00181335	0.000536693	-3.378748825	0.00103234	-0.002878136	-0.00074857
Regression Statistics of Lower Bound (3rd Order)						
Multiple R	0.402959316					
R Square	0.16237621					
Adjusted R Square	0.136993671					
Standard Error	1.067902024					
Observations	103					
Analysis of Variance						
	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*	
Regression	3	21.88625285	7.295417616	6.39716184	0.000524705	
Residual	99	112.9010586	1.140414733			
Total	102	134.7873114				
	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1.657140556	0.481398405	3.442347418	0.00083752	0.70194151	2.612339602
Occ	0.229012519	0.076617105	2.98905209	0.00350686	0.076987533	0.381037506
Occ^2	-0.00718338	0.003304198	-2.174015995	0.03201662	-0.013739627	-0.00062713
Occ^3	6.70854E-05	4.0739E-05	1.646710793	0.10269521	-1.37497E-05	0.00014792

Regression Statistics of Lower Bound (4th Order)						
Multiple R	0.540570911					
R Square	0.29221691					
Adjusted R Square	0.263327805					
Standard Error	0.986646452					
Observations	103					
Analysis of Variance						
	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*	
Regression	4	39.38713169	9.846782922	10.1151248	6.76595E-07	
Residual	98	95.40017975	0.973471222			
Total	102	134.7873114				
	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.05513249	0.60075199	-0.09177247	0.92705881	-1.247305243	1.137040255
Occ	0.788853127	0.1498154	5.265500924	7.7938E-07	0.491549347	1.086156907
Occ^2	-0.05264387	0.011147889	-4.72231688	7.4612E-06	-0.07476649	-0.03052124
Occ^3	0.00137817	0.000311499	4.424320739	2.4277E-05	0.000760011	0.001996329
Occ^4	-1.229E-05	2.89864E-06	-4.240024543	4.9213E-05	-1.80426E-05	-6.538E-06
Regression Statistics of Upper Bound: zero intercept (2nd Order)						
Regression Statistics						
Multiple R	0.949614622					
R Square	0.901767931					
Adjusted R Square	0.890894346					
Standard Error	1.701882569					
Observations	103					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	2685.480791	1342.740395	463.588735	2.61653E-51	
Residual	101	292.5368321	2.896404279			
Total	103	2978.017623				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	1.200518409	0.021956317	54.67758712	7.5261E-77	1.156962989	1.244073829
Occ^2	-0.01911404	0.000540482	-35.36479973	1.058E-58	-0.020186208	-0.01804187

Regression Statistics of Upper Bound: zero intercept (3rd Order)

Regression Statistics	
Multiple R	0.957725031
R Square	0.917237235
Adjusted R Square	0.90558198
Standard Error	1.620518456
Observations	103

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2910.413171	970.1377237	369.424275	1.31645E-53
Residual	100	262.6080066	2.626080066		
Total	103	3173.021178			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	1.066336169	0.052980538	20.12694106	6.0134E-37	0.961224278	1.171448059
Occ^2	-0.01031311	0.003158307	-3.265392718	0.00149754	-0.016579104	-0.00404712
Occ^3	-0.00012982	4.494E-05	-2.888837831	0.00474098	-0.000218984	-4.0665E-05

Regression Statistics of Upper Bound: zero intercept (4th Order)

Regression Statistics	
Multiple R	0.964274895
R Square	0.929826073
Adjusted R Square	0.91759858
Standard Error	1.499708244
Observations	103

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2950.357821	737.5894552	327.945097	8.51107E-56
Residual	99	222.6633569	2.249124817		
Total	103	3173.021178			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.708224489	0.098106733	7.218918298	1.0837E-10	0.513559412	0.902889566
Occ^2	0.031001432	0.010229925	3.030465165	0.00311565	0.010703037	0.051299827
Occ^3	-0.00152028	0.00033255	-4.571575025	1.401E-05	-0.002180131	-0.00086043
Occ^4	1.42634E-05	3.38454E-06	4.214271682	5.5393E-05	7.5477E-06	2.0979E-05

Regression Statistics of Lower Bound: zero intercept (2nd Order)

Regression Statistics	
Multiple R	0
R Square	-0.14113988
Adjusted R Square	-0.16233929
Standard Error	1.274604015
Observations	103

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	-20.29470775	-10.14735387	-6.24600376	#NUM!
Residual	101	164.086155	1.624615396		
Total	103	143.7914473			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.279588311	0.016670882	16.77105693	5.9218E-31	0.24651777	0.312658852
Occ^2	-0.00443834	0.000414218	-10.71499375	2.3967E-18	-0.005260034	-0.00361664

Regression Statistics of Lower Bound: zero intercept (3rd Order)

Regression Statistics	
Multiple R	0.401541642
R Square	0.161235691
Adjusted R Square	0.134460404
Standard Error	1.098212793
Observations	103

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	23.1843133	7.728104434	6.40766776	0.000518144
Residual	100	120.607134	1.20607134		
Total	103	143.7914473			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.477162542	0.0359045	13.28976988	7.9777E-24	0.405929029	0.548396055
Occ^2	-0.01710952	0.00214036	-7.993758227	2.3442E-12	-0.021355935	-0.01286311
Occ^3	0.00018286	3.04555E-05	6.004175526	3.1131E-08	0.000122437	0.000243283

Regression Statistics of Lower Bound: zero intercept (4th Order)						
Regression Statistics						
Multiple R	0.540514646					
R Square	0.292156083					
Adjusted R Square	0.260605257					
Standard Error	0.981692923					
Observations	103					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	4	39.37893293	9.844733233	10.2153354	5.91072E-07	
Residual	99	95.40837851	0.963720995			
Total	103	134.7873114				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.776412104	0.063453754	12.23587339	1.6106E-21	0.650506067	0.902318142
Occ^2	-0.05181909	0.006562813	-7.895866347	4.0087E-12	-0.064841139	-0.03879705
Occ^3	0.00135728	0.000211579	6.415013335	4.859E-09	0.000937462	0.001777098
Occ^4	-1.2111E-05	2.13525E-06	-5.672172437	1.4008E-07	-1.63483E-05	-7.8747E-06
Regression Statistics of Upper Bound: zero intercept (2nd Order)						
Fitted for the whole occupancy range: up to 99%						
Regression Statistics						
Multiple R	0.688314315					
R Square	0.473776596					
Adjusted R Square	0.459512826					
Standard Error	4.023865882					
Observations	109					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	1559.819036	779.9095179	48.1678461	1.31634E-15	
Residual	107	1732.49014	16.19149664			
Total	109	3292.309176				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.829029551	0.029621568	27.98736206	4.8476E-51	0.770308209	0.887750894
Occ^2	-0.00939763	0.000570432	-16.4745851	4.0528E-31	-0.01052845	-0.00826682

Regression Statistics of Upper Bound: zero intercept (3rd Order)

Fitted for the whole occupancy range: up to 99%

Regression Statistics	
Multiple R	0.930493568
R Square	0.86581828
Adjusted R Square	0.853852588
Standard Error	2.041474926
Observations	109

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	2850.541469	950.1804898	227.99116	7.97791E-46
Residual	106	441.7677065	4.167619873		
Total	109	3292.309176			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	1.354672994	0.03343648	40.51482042	2.4851E-66	1.288381882	1.420964107
Occ^2	-0.03035114	0.001225317	-24.77001808	6.9029E-46	-0.032780448	-0.02792182
Occ^3	0.000177116	1.00643E-05	17.59836735	3.1372E-33	0.000157162	0.000197069

Regression Statistics of Upper Bound: zero intercept (4th Order)

Fitted for the whole occupancy range: up to 99%

Regression Statistics	
Multiple R	0.933649211
R Square	0.871700849
Adjusted R Square	0.858511349
Standard Error	2.005707268
Observations	109

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2869.908703	717.4771758	178.349951	1.27499E-45
Residual	105	422.4004726	4.022861644		
Total	109	3292.309176			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	1.234081922	0.064029662	19.27359736	2.8756E-36	1.10712284	1.361041003
Occ^2	-0.02169503	0.004124676	-5.25981338	7.6575E-07	-0.029873504	-0.01351655
Occ^3	2.38892E-07	8.1217E-05	0.002941398	0.99765869	-0.0001608	0.000161277
Occ^4	1.03494E-06	4.71681E-07	2.194149679	0.03042869	9.96817E-08	1.97019E-06

Regression Statistics of Lower Bound: zero intercept (2nd Order)						
Fitted for the whole occupancy range: up to 99%						
Regression Statistics						
Multiple R	0					
R Square	-0.56078055					
Adjusted R Square	-0.58471308					
Standard Error	1.518215274					
Observations	109					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	-88.61384656	-44.30692328	-19.2222792	#NUM!	
Residual	107	246.632605	2.304977617			
Total	109	158.0187584				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.194124269	0.011176296	17.36928452	6.5026E-33	0.171968551	0.216279988
Occ^2	-0.00222526	0.000215226	-10.3391798	8.6866E-18	-0.002651916	-0.0017986

Regression Statistics of Lower Bound: zero intercept (3rd Order)						
Fitted for the whole occupancy range: up to 99%						
Regression Statistics						
Multiple R	0.255602348					
R Square	0.06533256					
Adjusted R Square	0.038263363					
Standard Error	1.180402028					
Observations	109					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	10.32377005	3.441256683	2.46977377	0.065983875	
Residual	106	147.6949884	1.393348947			
Total	109	158.0187584				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.339655279	0.019333321	17.56838814	3.5907E-33	0.301325069	0.37798549
Occ^2	-0.0080265	0.000708491	-11.32899872	5.6817E-20	-0.009431151	-0.00662184
Occ^3	4.90367E-05	5.81929E-06	8.426568881	1.8989E-13	3.74993E-05	6.0574E-05

Regression Statistics of Lower Bound: zero intercept (4th Order)						
Fitted for the whole occupancy range: up to 99%						
Regression Statistics						
Multiple R	0.411870693					
R Square	0.169637468					
Adjusted R Square	0.136389015					
Standard Error	1.117875776					
Observations	109					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	4	26.80590205	6.701475513	5.36269805	0.00057594	
Residual	105	131.2128564	1.249646251			
Total	109	158.0187584				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
Occ	0.450902214	0.035686767	12.63499755	8.3212E-23	0.380141897	0.521662531
Occ^2	-0.01601188	0.002298878	-6.965084376	2.9647E-10	-0.02057013	-0.01145362
Occ^3	0.000212208	4.52661E-05	4.688008523	8.3245E-06	0.000122453	0.000301962
Occ^4	-9.5474E-07	2.6289E-07	-3.631726614	0.00043721	-1.47601E-06	-4.3348E-07

Appendix B Current TSMC Error Flags

Flag 0 It is a good detection loop.

Flag 1 Short pulse: lane occupancy is less than 1 percent in a five-minute period.

Flag 2 Chattering: more than 17 detections in a 20-second period.

Flag 3 The traffic data is outside the acceptable volume vs. occupancy regions.

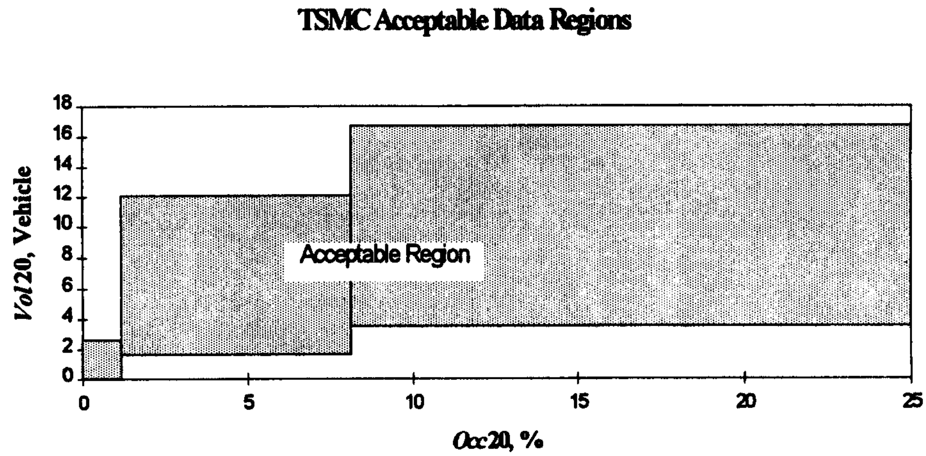


Figure B-1. TSMC Acceptable Data Regions

Occupancy Range (%)	Lower Volume (veh/20-sec)	Upper Volume (veh/20-sec)
0.0 - 1.0	0	2
1.1 - 8.0	1	12
8.1 - 14.0	3	17
14.1 - 25.0	3	17

Table B-1. Upper and Lower Volumes for Different Occupancy Ranges.

Flag 4 Reserved

Flag 5 Reserved

Flag 6 Operator disable

Flag 7 Hanging on or Hanging off
Hanging on - the loop has been on for the last three minutes
Hanging off - no vehicles have passed over the loop during the last 255 minutes

Appendix C Manual Detector Actuation Records

Name: Mark
Date: 9/12/89

Weather: Clear/Dry
Traffic Conditions: Moderate

Time	*Station*	*Det.*	*Action Taken*	*Comments*
8:42 to 8:43	NB 130th ES 18	33 (913) 34 (914) 35 (915)	Pulse (2) High Sens (5) Low Sens (1)	OK No difference in pulse length Questionable
8:52:40	ES 18	33, 34, 35	Reset	Normal at this time
9:06:40	ES 23.6	34 (751) 35 (752) 36 (753)	Pulse Low Sen 2 → 1 High 2 → 7	Short pulses Questionable Short pulses? (Looks normal)
9:11:20	ES 23.6	36 (753)	Rest Amp 7 → 6	
9:14:00	ES 23.6	34, 35, 36	Sens back to 2	(Reset amp)
9:22:40	NB 205th ES 23.4	34 (878) 35(879) 36 (880)	Pulse (2) Low (1) High (6)	Good short pulse Questionable Hung for 1 min., returned to "normal" automatically
9:32:00	ES 23.4	34, 35, 36	Sens back to 2	
9:32:14	ES 23.4			Settled

Name: Les

Date: 9/12/89

Weather: Clear/Dry

Traffic Conditions: Moderate

Time	*Station*	*Det.*	*Action Taken*	*Comments*
8:42:00	ES 18	13 (910)	Sens 2 → 1	Questionable, Pulses seem OK
8:42:24	ES 18	12 (909)	Pulse 2	OK
8:42:30	ES 18	12, 13	Reset	
8:42:43	ES 18	14 (911)	Sens 2 → 5	No difference in pulse
8:52:37	ES 18	12, 13, 14	Reset amp	Reset Sens to 2
9:22:00 9:22:40 9:23:00	ES 23.4	 13 (875) 14 (876) 15 (877)	Pull amp Reinstall Settled Pulse Sens 2 → 1 Sens 2 → 6	 Short pulse Questionable Maybe a little long
9:26:00 9:26:40 9:28:00 9:29:00 9:32:00 9:32:14	ES 23.4	15 (877)	Sens 6 → 5 Manual hits (long) Back to normal Manual hits Sens → 2 Settled	Pulses look normal

Name: Les
Date: 9/12/89

Weather: Clear/Dry
Traffic Conditions: Moderate

Time	*Station*	*Det.*	*Action Taken*	*Comments*
15:02:00 15:03:00	ES 18		Amp out Amp in	
15:03:00	ES 18	13 (910) 14 (911) 15 (912)	Long Manual Pulse Sens 2 → 1	OK Questionable
15:09:10	ES 18	13	10 sec on 10 sec off (2 iterations then long manual)	
15:13:00	ES 18	13, 14, 15	Reset Sens → 2	
15:24:10 15:25:00	ES 18.8		Amp out Amp in	
15:25:00	ES 18.8	13 (781) 14 (782)	Pulse Sens → 1	OK OK initially → Questionable
15:27:00 15:32:00	ES 18.8	15 (783) 13, 14	Manual actuations ~60/min until 15:32 Sens → 2, 15 hung until 15:34	
15:47:20 15:48:00 15:48:10	ES 23.6		Amp out Amp in Settled	
15:48:10	ES 23.6	34 (751) 35 (752) 36 (753)	Pulse Sens → 1 Long manual actuations	Heavy traffic Looks normal
15:53:00 15:53:20	ES 23.6		Back to normal Settled	

Name: Les
Date: 9/12/89

Weather: Clear/Dry
Traffic Conditions: Heavy NB, Light SB

Time	*Station*	*Det.*	*Action Taken*	*Comments*
16:01:40 16:02:00 16:02:09	ES 23.4		Amp out Amp in Settled	
16:02:09	ES 23.4	14 (876) 15 (877)	Pulse Sens 2 → 1	OK Questionable, close to normal
16:05:00 16:08:00 16:09:00	ES 23.4	13 (875)	Manual actuations Normal Manual actuations	> 17 in 20 sec.
16:12:00 16:12:20	ES 23.4	13, 14, 15	Normal	Settled

Name: Mark
Date: 9/12/89

Weather: Clear/Dry
Traffic Conditions: Moderate

Time	*Station*	*Det.*	*Action Taken*	*Comments*
15:03:00 to 15:13:12	NB 130th ES 18	32 (913) 33 (914) 34 (915) 35 (916)	Pulse (2) Low (1) High (6) No change	Good Looks normal Questionable
16:02:00 16:02:09	NB 205th ES 23.4	34 (878) 35 (879) 36 (880)	Low (1) Pulse (2) Normal	Heavy traffic Short
16:12:20	ES 23.4	34, 35, 36	Normal (2)	

Name: Les
Date: 9/13/89

Weather: Clear/Dry
Traffic Conditions: Moderate

Time	*Station*	*Det.*	*Action Taken*	*Comments*
8:49:12 8:49:20 8:49:54	ES 23.4	13 (875) 14 (876) 15 (877)	Low Sens 2 → 1 Manual Pulse	Questionable (Pulses look OK) Settled Many OK
8:52:00 8:52:20	ES 23.4	14	OFF Long	
8:54:00 8:54:20	ES 23.4	13, 14, 15	Sens → 2	 Settled
9:03:30	ES 18	 13 (910) 14 (911) 15 (912)	 Manual Many 9:04:00 → 9:08:00 Pulse Sens 2 → 1	Settled OK (Maybe short) initially anyway
9:09:00	ES 18	13	Long Pulse	
9:13:00 9:13:20	ES 18	13, 14, 15	Normal Sens 2	 Settled

Name:	Mark	***Weather:***	Clear/Dry
Date:	9/13/89	***Traffic Conditions:***	Light

Time	*Station*	*Det.*	*Action Taken*	*Comments*
8:49:00 8:49:20	NB 205th ES 23.4	34 (878) 35 (879) 36 (880)	Low (1) High (6) Pulse (1)	Very long hits
Reset @ 8:49:45 8:54:13		All	Normal (2)	Reset @ 8:50:25, 51:10, 51:50, 52:46, 53:25, 53:40
9:03:00 9:03:20	NB 130th ES 18	32 (913) 33 (914) 34 (915) 35 (916)	Control loop Low (1) Pulse (1) High (7)	Look short sometimes Good Questionable (look short)
9:13:12		All	Normal (2)	

Name: Mark
Date: 9/13/89

Weather: Clear/Dry
Traffic Conditions: Moderate

Time	*Station*	*Det.*	*Action Taken*	*Comments*
15:03:00 15:03:13	NB 130th ES 18	32 (913) 33 (914) 34 (915) 35 (916)	Control pulse High (6) Low (1) Pulse (1)	 Slightly higher occ Looks normal Looks short
15:13:13		All	Reset	
15:30:20	NB 244th ES 23.6	34 (751) 35 (752) 36 (753)	Manual very long Pulse Low	(inverse of amp pulse) OK Questionable (A little short)
15:34:00		34, 35, 36	Normal	
15:34:16				Settled
15:42:00 15:42:16 15:43:00 15:48:00	NB 205th ES 23.4	34 (878) 36 (880) 35 (879) 35 (879)	High Low Manual Manual	Questionable 1 sec hits long hits (inverse of pulse)
15:52:13		All	Normal	

Name: Les
Date: 9/13/89
SB

Weather: Clear/Dry
Traffic Conditions: Moderate NB, Light

Time	*Station*	*Det.*	*Action Taken*	*Comments*
15:03:00 15:03:13	ES 18	13 (910) 14 (911)	Pulse Sens 2 → 1	OK Questionable (maybe Low) Settled
15:04:00 15:08:00 15:09:00		15 (912)	Manual (long) Normal Many	
15:13:00 15:13:13		13, 14, 15	Normal	 Settled
15:42:00 15:42:16	ES 23.4	13 (875) 14 (876)	Pulse Sens 2 → 1	OK Settled A little short
15:43:00 15:47:00 15:48:00		15 (877)	Manual long Normal Manual many	
15:52:00 15:52:15		13, 14, 15	Normal	 Settled
16:03:00 16:07:00 16:08:00	ES 18.8	13 (781)	Manual many Normal Manual long	
16:02:00 (16:02:12 Settled) 16:12:00		14 15 13, 14, 15	Pulse 2 → 1 Sens 2 → 1 Normal	OK Maybe a little short 16:12:06 → Settled

Appendix D Algorithm Test Results

8:55:32	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	909					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:40:41	9	13	0	0		
8:41:01	7	9	0	0		
8:41:21	6	7	0	0		
8:41:41	9	11	0	0		
8:42:01	11	13	0	0	Pulse	
8:42:21	7	16	0	0	Start	
8:42:41	10	13	0	0		
8:43:01	6	8	0	0		
8:43:21	3	32	5	0		
8:43:41	13	24	0	0		
8:44:01	7	7	0	0		
8:44:21	13	16	0	0		
8:44:41	6	4	2	2		1
8:45:01	4	2	2	2		2
8:45:21	8	5	2	2		3
8:45:41	8	5	2	2		4
8:46:01	5	3	2	2		5
8:46:21	4	2	2	2		6
8:46:41	9	6	2	2		7
8:47:01	4	2	2	2		8
8:47:21	6	4	2	2		9
8:47:41	6	4	2	2		10
8:48:01	6	4	2	2		11
8:48:21	7	4	2	2		12
8:48:41	6	4	2	2		13
8:49:01	7	4	2	2		14
8:49:21	7	4	2	2		15
8:49:41	7	4	2	2		16
8:50:01	8	5	2	2		17
8:50:21	4	2	2	2		18
8:50:41	4	2	2	2		19
8:51:01	6	4	2	2		20
8:51:21	3	2	2	2		21
8:51:41	6	4	2	2		22
8:52:01	7	4	2	2		23
8:52:21	4	2	2	2		24
8:52:41	5	3	2	2	End	25
8:53:01	6	4	2	2		26
8:53:21	3	2	2	2		27
8:53:41	7	9	0	0		
8:54:01	6	7	0	0		
8:54:21	7	9	0	0		
8:54:41	5	6	0	0		
8:55:01	8	11	0	0		
8:55:21	12	20	0	0		

8:55:38	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	910					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:40:41	7	11	0	0		
8:41:01	7	9	0	0		
8:41:21	9	13	0	0		
8:41:41	7	8	0	0	Sens to (1)	
8:42:01	7	7	0	0	Start	1
8:42:21	9	12	0	0	??? effect	2
8:42:41	12	18	0	0		3
8:43:01	11	13	0	0		4
8:43:21	6	63	0	0		5
8:43:41	10	19	0	0		6
8:44:01	8	8	0	0		7
8:44:21	10	13	0	0		8
8:44:41	6	8	0	0		9
8:45:01	5	9	0	0		10
8:45:21	11	16	0	0		11
8:45:41	10	15	0	0		12
8:46:01	12	20	0	0		13
8:46:21	7	7	0	0		14
8:46:41	12	14	0	0		15
8:47:01	6	11	0	0		16
8:47:21	5	5	0	0		17
8:47:41	8	10	0	0		18
8:48:01	8	13	0	0		19
8:48:21	12	16	0	0		20
8:48:41	11	12	0	0		21
8:49:01	12	14	0	0		22
8:49:21	8	12	0	0		23
8:49:41	7	11	0	0		24
8:50:01	9	10	0	0		25
8:50:21	12	15	0	0		26
8:50:41	10	12	0	0		27
8:51:01	8	10	0	0		28
8:51:21	9	14	0	0		29
8:51:41	13	19	0	0		30
8:52:01	12	15	0	0		31
8:52:21	9	9	0	0		32
8:52:41	13	15	0	0	End	33
8:53:01	6	6	0	0		
8:53:21	8	7	0	0		
8:53:41	8	10	0	0		
8:54:01	8	9	0	0		
8:54:21	4	4	0	0		
8:54:41	7	8	0	0		
8:55:01	5	6	0	0		
8:55:21	8	19	0	0		

8:55:44	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	911					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:40:41	7	8	0	0		
8:41:01	9	10	0	0		
8:41:21	12	13	0	0		
8:41:41	13	18	0	0		
8:42:01	9	10	0	0		
8:42:21	13	14	0	0	Sens to (5)	
8:42:41	14	19	0	0	Start	1
8:43:01	13	15	0	0	??? effect	2
8:43:21	8	26	0	0		3
8:43:41	10	29	0	0		4
8:44:01	6	11	0	0		5
8:44:21	8	11	0	0		6
8:44:41	8	13	0	0		7
8:45:01	11	16	0	0		8
8:45:21	10	18	0	0		9
8:45:41	11	17	0	0		10
8:46:01	10	15	0	0		11
8:46:21	11	17	0	0		12
8:46:41	11	25	0	0		13
8:47:01	12	18	0	0		14
8:47:21	10	17	0	0		15
8:47:41	10	17	0	0		16
8:48:01	13	19	0	0		17
8:48:21	10	19	0	0		18
8:48:41	9	15	0	0		19
8:49:01	13	19	0	0		20
8:49:21	12	18	0	0		21
8:49:41	10	16	0	0		22
8:50:01	11	16	0	0		23
8:50:21	10	15	0	0		24
8:50:41	13	18	0	0		25
8:51:01	11	17	0	0		26
8:51:21	8	16	0	0		27
8:51:41	9	14	0	0		28
8:52:01	10	16	0	0		29
8:52:21	11	14	0	0		30
8:52:41	14	22	0	0	End	31
8:53:01	13	19	0	0		
8:53:21	7	13	0	0		
8:53:41	6	67	0	0		
8:54:01	9	14	0	0		
8:54:21	9	10	0	0		
8:54:41	8	9	0	0		
8:55:01	6	6	0	0		
8:55:21	14	22	0	0		

8:55:55	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	913					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:40:41	2	2	0	0		
8:41:01	5	7	0	0		
8:41:21	5	6	0	0		
8:41:41	5	5	0	0	Pulse	
8:42:01	4	4	0	0	Start	
8:42:21	3	3	0	0		
8:42:41	6	9	0	0		
8:43:01	3	3	0	0		
8:43:21	4	22	5	3		1
8:43:41	4	22	5	3		2
8:44:01	1	6	5	3		3
8:44:21	4	7	0	0		4
8:44:41	4	5	0	0		5
8:45:01	5	5	0	0		6
8:45:21	3	4	0	0		7
8:45:41	3	2	2	2		8
8:46:01	5	5	0	0		9
8:46:21	4	4	0	0		10
8:46:41	4	3	2	0		11
8:47:01	7	11	0	0		12
8:47:21	3	3	0	0		13
8:47:41	2	2	0	0		14
8:48:01	2	2	0	0		15
8:48:21	9	11	0	0		16
8:48:41	6	6	0	0		17
8:49:01	2	2	0	0		18
8:49:21	3	3	0	0		19
8:49:41	6	4	2	2		20
8:50:01	2	2	0	0		21
8:50:21	4	4	0	0		22
8:50:41	4	4	0	0		23
8:51:01	5	7	0	0		24
8:51:21	0	0	0	0		25
8:51:41	3	4	0	0		26
8:52:01	2	2	0	0	End	27
8:52:21	0	0	0	0		
8:52:41	3	6	0	0		
8:53:01	7	8	0	0		
8:53:21	3	3	0	0		
8:53:41	4	40	0	0		
8:54:01	4	8	0	0		
8:54:21	2	3	0	0		
8:54:41	2	4	0	0		
8:55:01	6	7	0	0		
8:55:21	5	7	0	0		

8:56:01	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	914					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:40:41	6	8	0	0		
8:41:01	4	4	0	0		
8:41:21	4	5	0	0		
8:41:41	8	9	0	0	Sens to (5)	
8:42:01	9	13	0	0	Start	
8:42:21	9	9	0	0	??? effect	
8:42:41	5	5	0	0		
8:43:01	2	2	0	0		
8:43:21	5	22	0	0		
8:43:41	2	20	5	3		1
8:44:01	1	0	4	0		2
8:44:21	4	2	2	2		3
8:44:41	2	1	2	2		4
8:45:01	1	0	4	0		5
8:45:21	5	3	2	2		6
8:45:41	0	0	0	0		
8:46:01	3	2	2	2		7
8:46:21	4	2	2	2		8
8:46:41	7	4	2	2		9
8:47:01	5	3	2	2		10
8:47:21	5	3	2	2		11
8:47:41	0	0	0	0		
8:48:01	3	2	2	2		12
8:48:21	2	1	2	2		13
8:48:41	2	1	2	2		14
8:49:01	5	3	2	2		15
8:49:21	3	2	2	2		16
8:49:41	3	2	2	2		17
8:50:01	6	3	2	2		18
8:50:21	2	1	2	2		19
8:50:41	2	1	2	2		20
8:51:01	3	2	2	2		21
8:51:21	3	2	2	2		22
8:51:41	2	1	2	2		23
8:52:01	2	1	2	2	End	24
8:52:21	4	2	2	2		25
8:52:41	2	1	2	2		26
8:53:01	6	4	2	2		27
8:53:21	2	1	2	2		28
8:53:41	6	37	0	0		
8:54:01	5	12	0	0		
8:54:21	5	7	0	0		
8:54:41	4	4	0	0		
8:55:01	5	7	0	0		
8:55:21	4	4	0	0		

8:56:07	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	915					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:40:41	7	8	0	0		
8:41:01	6	6	0	0		
8:41:21	5	5	0	0		
8:41:41	8	7	0	0	Sens to (1)	
8:42:01	5	9	0	0	Start	1
8:42:21	6	7	0	0	??? effect	2
8:42:41	6	6	0	0		3
8:43:01	3	3	0	0		4
8:43:21	8	12	0	0		5
8:43:41	7	6	0	0		6
8:44:01	6	42	0	0		7
8:44:21	9	14	0	0		8
8:44:41	6	15	0	0		9
8:45:01	9	11	0	0		10
8:45:21	7	9	0	0		11
8:45:41	4	5	0	0		12
8:46:01	6	7	0	0		13
8:46:21	7	9	0	0		14
8:46:41	6	9	0	0		15
8:47:01	5	6	0	0		16
8:47:21	5	5	0	0		17
8:47:41	8	9	0	0		18
8:48:01	4	8	0	0		19
8:48:21	7	8	0	0		20
8:48:41	7	9	0	0		21
8:49:01	7	9	0	0		22
8:49:21	5	10	0	0		23
8:49:41	6	8	0	0		24
8:50:01	7	9	0	0		25
8:50:21	9	12	0	0		26
8:50:41	7	9	0	0		27
8:51:01	11	14	0	0		28
8:51:21	3	4	0	0		29
8:51:41	7	8	0	0		30
8:52:01	9	20	0	0		31
8:52:21	7	8	0	0		32
8:52:41	2	3	0	0	End	33
8:53:01	9	13	0	0		
8:53:21	8	11	0	0		
8:53:41	11	15	0	0		
8:54:01	5	5	0	0		
8:54:21	9	8	2	2		
8:54:41	5	5	0	0		
8:55:01	5	5	0	0		
8:55:21	3	7	0	0		

9:16:18	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	751					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
9:00:41	7	13	0	0		
9:01:01	2	4	0	0		
9:01:21	8	10	0	0		
9:01:41	8	9	0	0		
9:02:01	4	4	0	0		
9:02:21	5	4	2	0		
9:02:41	6	6	0	0		
9:03:01	4	4	0	0		
9:03:21	4	5	0	0		
9:03:41	7	8	0	0		
9:04:01	5	6	0	0		
9:04:21	5	5	0	0		
9:04:41	7	10	0	0		
9:05:01	6	6	0	0		
9:05:21	5	9	0	0		
9:05:41	3	3	0	0		
9:06:01	9	12	0	0		
9:06:21	4	5	0	0	Pulse	
9:06:41	3	5	0	0	Start	
9:07:01	3	4	0	0		
9:07:21	4	5	0	0		
9:07:41	4	11	0	0		
9:08:01	2	4	0	0		
9:08:21	1	0	4	0		1
9:08:41	3	2	2	2		2
9:09:01	6	4	2	2		3
9:09:21	1	0	4	0		4
9:09:41	3	2	2	2		5
9:10:01	1	0	4	0		6
9:10:21	4	2	2	2		7
9:10:41	5	3	2	2		8
9:11:01	3	2	2	2		9
9:11:21	2	1	2	2		10
9:11:41	1	0	4	0		11
9:12:01	6	4	2	2		12
9:12:21	4	2	2	2		13
9:12:41	1	36	5	3		14
9:13:01	8	5	2	2		15
9:13:21	3	2	2	2		16
9:13:41	3	1	2	2		17
9:14:01	5	3	2	2	End	18
9:14:21	1	0	4	0		19
9:14:41	1	0	4	0		20
9:15:01	2	1	2	2		21
9:15:21	5	44	0	0		

15:16:09	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	910					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	8	9.3	0	0		
15:01:31	5	6	0	0		
15:01:51	10	11.3	0	0		
15:02:11	8	7.6	0	0		
15:02:31	5	4.6	0	0		
15:02:51	6	8.6	0	0	Long hits	
15:03:11	6	8	0	0	start	
15:03:31	2	39	5	0		1
15:03:51	4	6	0	0		2
15:04:11	7	14.6	0	0		3
15:04:31	6	24	0	0		4
15:04:51	5	28	0	0		5
15:05:11	5	20.6	0	0		6
15:05:31	7	32	0	0		7
15:05:51	9	41.3	0	0		8
15:06:11	4	18.6	5	0		9
15:06:31	4	14.6	0	0		10
15:06:51	7	35	0	0		11
15:07:11	9	45.3	0	0		12
15:07:31	9	32.3	0	0		13
15:07:51	9	38.3	0	0		14
15:08:11	3	15.6	5	3		15
15:08:31	10	48	0	0		16
15:08:51	6	30	0	0		17
15:09:11	8	30	0	0	10 sec on/	18
15:09:31	2	33.3	5	3	10 sec off	19
15:09:51	4	35	0	0		20
15:10:11	0	69	5	3		21
15:10:31	0	40	5	3		22
15:10:51	0	29.6	5	3		23
15:11:11	4	24	5	3		24
15:11:31	5	19.3	0	0		25
15:11:51	6	34	0	0		26
15:12:11	7	35.3	0	0		27
15:12:31	5	20.6	0	0		28
15:12:51	7	37	0	0	End	29
15:13:11	5	23.3	0	0		30
15:13:31	6	21.6	0	0		31
15:13:51	7	30.6	0	0		32
15:14:11	6	9	0	0		
15:14:31	10	11.6	0	0		
15:14:51	15	19	0	0		
15:15:11	7	8.6	0	0		
15:15:31	7	7.3	0	0		
15:15:51	4	4.3	0	0		

15:16:15	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	911					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	5	5.6	0	0		
15:01:31	8	9.6	0	0		
15:01:51	8	9	0	0		
15:02:11	10	10.3	0	0		
15:02:31	6	6.3	0	0		
15:02:51	12	17	0	0	Pulse	
15:03:11	10	10.6	0	0	Start	
15:03:31	0	0	0	0		
15:03:51	0	0	0	0		
15:04:11	6	32.6	0	0		
15:04:31	7	4.6	2	2		1
15:04:51	4	2.6	2	2		2
15:05:11	6	4	2	2		3
15:05:31	6	4	2	2		4
15:05:51	8	5.3	2	2		5
15:06:11	2	1.3	2	2		6
15:06:31	9	6	2	2		7
15:06:51	3	2	2	2		8
15:07:11	6	4	2	2		9
15:07:31	7	4.6	2	2		10
15:07:51	5	3.3	2	2		11
15:08:11	1	0.6	2	2		12
15:08:31	9	6	2	2		13
15:08:51	6	4	2	2		14
15:09:11	9	6	2	2		15
15:09:31	2	1.3	2	2		16
15:09:51	7	4.6	2	2		17
15:10:11	4	2.6	2	2		18
15:10:31	7	4.6	2	2		19
15:10:51	6	4	2	2		20
15:11:11	6	4	2	2		21
15:11:31	7	4.6	2	2		22
15:11:51	6	4	2	2		23
15:12:11	6	4	2	2		24
15:12:31	6	4	2	2		25
15:12:51	2	1.3	2	2	End	26
15:13:11	3	2	2	2		27
15:13:31	7	4.6	2	2		28
15:13:51	6	4	2	2		29
15:14:11	7	8.3	0	0		
15:14:31	13	12.6	2	0		
15:14:51	16	21	0	0		
15:15:11	13	13.3	0	0		
15:15:31	9	10.3	0	0		
15:15:51	10	10.6	0	0		

15:16:27	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	913					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	9	11.3	0	0		
15:01:31	7	9.3	0	0		
15:01:51	8	9.6	0	0		
15:02:11	5	5	0	0		
15:02:31	8	10.3	0	0		
15:02:51	6	7.6	0	0	Pulse	
15:03:11	10	11.3	0	0	Start	
15:03:31	0	0	0	0		
15:03:51	0	0	0	0		
15:04:11	1	27.3	5	3		
15:04:31	5	3.3	2	2		1
15:04:51	4	2.6	2	2		2
15:05:11	4	2.6	2	2		3
15:05:31	5	3.3	2	2		4
15:05:51	1	0.6	2	2		5
15:06:11	3	2	2	2		6
15:06:31	4	2.6	2	2		7
15:06:51	4	2.6	2	2		8
15:07:11	4	2.6	2	2		9
15:07:31	4	2.6	2	2		10
15:07:51	4	2.6	2	2		11
15:08:11	7	4.6	2	2		12
15:08:31	8	5.3	2	2		13
15:08:51	5	3.3	2	2		14
15:09:11	3	2	2	2		15
15:09:31	6	4	2	2		16
15:09:51	5	3.3	2	2		17
15:10:11	2	1.3	2	2		18
15:10:31	8	5.3	2	2		19
15:10:51	6	4	2	2		20
15:11:11	3	2	2	2		21
15:11:31	2	1.3	2	2		22
15:11:51	5	3.3	2	2		23
15:12:11	0	0	0	0		
15:12:31	4	2.6	2	2		24
15:12:51	2	1.3	2	2		25
15:13:11	3	2	2	2	End	26
15:13:31	7	4.6	2	2		27
15:13:51	2	1.3	2	2		28
15:14:11	6	4.6	2	0		29
15:14:31	9	10.6	0	0		
15:14:51	11	14.6	0	0		
15:15:11	10	13.3	0	0		
15:15:31	11	16.6	0	0		
15:15:51	9	13.6	0	0		

15:16:33	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	914					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	7	9	0	0		
15:01:31	10	14.6	0	0		
15:01:51	8	9.3	0	0		
15:02:11	10	12.3	0	0		
15:02:31	8	10.6	0	0		
15:02:51	9	10.3	0	0	Sens to (1)	
15:03:11	9	11	0	0	Start	1
15:03:31	0	0	0	0	??? effect	2
15:03:51	0	0	0	0		3
15:04:11	3	30.3	5	0		4
15:04:31	8	9.6	0	0		5
15:04:51	7	8	0	0		6
15:05:11	9	8.3	0	0		7
15:05:31	7	6.6	0	0		8
15:05:51	8	9.3	0	0		9
15:06:11	8	10	0	0		10
15:06:31	7	7	0	0		11
15:06:51	10	10.3	0	0	-	12
15:07:11	7	7.3	0	0		13
15:07:31	14	15.3	0	0		14
15:07:51	9	12.6	0	0		15
15:08:11	8	7.6	0	0		16
15:08:31	7	7.3	0	0		17
15:08:51	9	9	0	0		18
15:09:11	5	5.3	0	0		19
15:09:31	8	12	0	0		20
15:09:51	7	7	0	0		21
15:10:11	5	5.3	0	0		22
15:10:31	8	7.6	0	0		23
15:10:51	9	11	0	0		24
15:11:11	7	7	0	0		25
15:11:31	8	8.3	0	0		26
15:11:51	10	10.3	0	0		27
15:12:11	7	7.3	0	0		28
15:12:31	6	6.3	0	0		29
15:12:51	2	2	0	0	End	30
15:13:11	3	3.3	0	0		
15:13:31	6	8.3	0	0		
15:13:51	9	10.3	0	0		
15:14:11	12	18	0	0		
15:14:31	8	15.3	0	0		
15:14:51	8	12.6	0	0		
15:15:11	10	14.6	0	0		
15:15:31	12	19.6	0	0		
15:15:51	8	13.6	0	0		

15:16:39	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	915					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	8	11.6	0	0		
15:01:31	12	13	0	0		
15:01:51	8	9.3	0	0		
15:02:11	12	17	0	0		
15:02:31	8	10.3	0	0		
15:02:51	12	15	0	0	Sens to (6)	
15:03:11	7	9	0	0	Start	
15:03:31	0	0	0	0	??? effect	
15:03:51	0	0	0	0		
15:04:11	3	39.3	5	0		1
15:04:31	13	20.6	0	0		2
15:04:51	8	16.3	0	0		3
15:05:11	11	18.6	0	0		4
15:05:31	10	17	0	0		5
15:05:51	13	19	0	0		6
15:06:11	10	15.3	0	0		7
15:06:31	9	13	0	0		8
15:06:51	8	10	0	0		9
15:07:11	9	18	0	0		10
15:07:31	7	13.3	0	0		11
15:07:51	10	18	0	0		12
15:08:11	14	21.3	0	0		13
15:08:31	13	20.6	0	0		14
15:08:51	7	13	0	0		15
15:09:11	11	21.3	0	0		16
15:09:31	12	22	0	0		17
15:09:51	9	14	0	0		18
15:10:11	10	17	0	0		19
15:10:31	9	14.6	0	0		20
15:10:51	12	20.6	0	0		21
15:11:11	3	4.3	0	0		22
15:11:31	11	16.6	0	0		23
15:11:51	14	22.3	0	0		24
15:12:11	6	9	0	0		25
15:12:31	7	11	0	0		26
15:12:51	8	10.6	0	0		27
15:13:11	9	14.6	0	0	End	28
15:13:31	7	21.6	0	0		
15:13:51	8	14	0	0		
15:14:11	7	20.6	0	0		
15:14:31	9	13.3	0	0		
15:14:51	11	18.3	0	0		
15:15:11	9	13.3	0	0		
15:15:31	10	17.3	0	0		
15:15:51	9	14	0	0		

15:37:50	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	781					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:21:11	6	7	0	0		
15:21:31	5	8.8	0	0		
15:21:51	7	10.5	0	0		
15:22:11	7	10.3	0	0		
15:22:31	6	7	0	0		
15:22:51	6	8	0	0		
15:23:11	8	9.5	0	0		
15:23:31	5	8.1	0	0		
15:23:51	6	6.9	0	0		
15:24:11	7	8.3	0	0		
15:24:31	4	3.9	0	0		
15:24:51	2	2.9	0	0	Pulse	
15:25:11	4	4.4	0	0	Start	
15:25:31	0	0	0	0		
15:25:51	0	0	0	0		
15:26:11	6	3.5	2	2		1
15:26:31	6	3.5	2	2		2
15:26:51	6	3.5	2	2		3
15:27:11	5	2.9	2	2		4
15:27:31	7	4.1	2	2		5
15:27:51	8	4.7	2	2		6
15:28:11	7	4	2	2		7
15:28:31	4	2.3	2	2		8
15:28:51	4	2.3	2	2		9
15:29:11	7	4	2	2		10
15:29:31	2	1.2	2	2		11
15:29:51	7	4.1	2	2		12
15:30:11	5	2.9	2	2		13
15:30:31	6	3.5	2	2		14
15:30:51	6	3	2	2		15
15:31:11	3	1.5	2	2		16
15:31:31	8	4.6	2	2		17
15:31:51	9	5.4	2	2	End	18
15:32:11	6	3.5	2	2		19
15:32:31	7	4	2	2		20
15:32:51	3	1.7	2	2		21
15:33:11	3	1.7	2	2		22
15:33:31	4	2.3	2	2		23
15:33:51	5	3	2	2		24
15:34:11	5	10.2	0	0		
15:34:31	5	6.4	0	0		
15:34:51	4	4.8	0	0		
15:35:11	6	7.4	0	0		
15:35:31	7	8.8	0	0		
15:35:51	7	8.3	0	0		

15:37:57	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	782					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:21:11	8	9.5	0	0		
15:21:31	7	8.4	0	0		
15:21:51	12	13.8	0	0		
15:22:11	14	16.5	0	0		
15:22:31	11	13.4	0	0		
15:22:51	9	10.2	0	0		
15:23:11	7	11.3	0	0		
15:23:31	9	10.5	0	0		
15:23:51	7	9.5	0	0		
15:24:11	10	10.2	0	0		
15:24:31	8	10.8	0	0		
15:24:51	5	5.3	0	0	Sens to (1)	
15:25:11	3	3.5	0	0	Start	
15:25:31	0	0	0	0	??? effect	
15:25:51	0	0	0	0		
15:26:11	12	7.1	2	2		1
15:26:31	8	4.6	2	2		2
15:26:51	9	7.9	2	0		3
15:27:11	10	9.5	0	0		4
15:27:31	6	6.9	0	0		5
15:27:51	10	9.6	0	0		6
15:28:11	13	13	2	0		7
15:28:31	7	7.1	0	0		8
15:28:51	8	10.6	0	0		9
15:29:11	9	7.1	2	0		10
15:29:31	13	14	0	0		11
15:29:51	7	10	0	0		12
15:30:11	4	3.3	0	0		13
15:30:31	3	2.8	0	0		14
15:30:51	5	6.6	0	0		15
15:31:11	6	5.8	0	0		16
15:31:31	12	14.1	0	0		17
15:31:51	9	9.5	0	0	End	18
15:32:11	6	7.9	0	0		
15:32:31	5	5.8	0	0		
15:32:51	7	7.8	0	0		
15:33:11	6	5	0	0		
15:33:31	6	5.4	0	0		
15:33:51	8	7.5	0	0		
15:34:11	10	14	0	0		
15:34:31	8	10.2	0	0		
15:34:51	6	6	0	0		
15:35:11	8	9.5	0	0		
15:35:31	4	4.6	0	0		
15:35:51	12	15.8	0	0		

15:56:53	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	751					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	9	16.6	0	0		
15:41:31	9	12.3	0	0		
15:41:51	11	18	0	0		
15:42:11	7	10.6	0	0		
15:42:31	10	18.3	0	0		
15:42:51	8	13.3	0	0		
15:43:11	5	6.6	0	0		
15:43:31	9	15.3	0	0		
15:43:51	11	23	0	0		
15:44:11	9	17.6	0	0		
15:44:31	6	13.6	0	0		
15:44:51	9	19.6	0	0		
15:45:11	9	23.6	0	0		
15:45:31	9	21.3	0	0		
15:45:51	10	27.6	0	0		
15:46:11	8	25	0	0		
15:46:31	7	37	0	0		
15:46:51	8	29	0	0		
15:47:11	10	22.6	0	0		
15:47:31	10	21	0	0		
15:47:51	8	16.6	0	0		
15:48:11	10	27	0	0	Pulse	
15:48:31	1	3.3	5	3	Start	
15:48:51	0	0	0	0		
15:49:11	4	39.3	0	0		
15:49:31	6	4	2	2		1
15:49:51	7	4.6	2	2		2
15:50:11	2	1.3	2	2		3
15:50:31	5	3.3	2	2		4
15:50:51	4	2.6	2	2		5
15:51:11	6	4	2	2		6
15:51:31	6	4	2	2		7
15:51:51	6	4	2	2		8
15:52:11	6	4	2	2		9
15:52:31	10	6.6	2	2		10
15:52:51	7	4.6	2	2		11
15:53:11	4	2.6	2	2	End	12
15:53:31	6	4	2	2		13
15:53:51	3	2	2	2		14
15:54:11	7	37	0	0		
15:54:31	8	30.3	0	0		
15:54:51	10	22.6	0	0		
15:55:11	8	15.6	0	0		
15:55:31	8	17.6	0	0		
15:55:51	12	21.3	0	0		

15:57:06	9/12/89					
REPORT NO.	DOT-R710295-02	**DESCARDED**				
DETECTOR	753					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	8	11.6	0	0		
15:41:31	15	21.6	0	0		
15:41:51	13	22.6	0	0		
15:42:11	11	25	0	0		
15:42:31	9	19	0	0		
15:42:51	16	24.6	0	0		
15:43:11	13	20	0	0		
15:43:31	9	14.6	0	0		
15:43:51	10	14.6	0	0		
15:44:11	6	9.3	0	0		
15:44:31	7	12.6	0	0		
15:44:51	10	17.3	0	0		
15:45:11	10	19.3	0	0		
15:45:31	12	26.3	0	0		
15:45:51	10	25	0	0		
15:46:11	11	29	0	0		
15:46:31	11	26	0	0		
15:46:51	10	26	0	0		
15:47:11	11	23	0	0		
15:47:31	10	18.6	0	0		
15:47:51	11	19	0	0	Long hits	
15:48:11	10	23.6	0	0	Start	
15:48:31	3	5.3	0	0		
15:48:51	0	0	0	0		
15:49:11	8	39	0	0		1
15:49:31	12	62	3	0		2
15:49:51	10	43	0	0		3
15:50:11	10	40.3	0	0		4
15:50:31	10	45	0	0		5
15:50:51	9	50.6	0	0		6
15:51:11	9	54.3	0	0		7
15:51:31	8	68	3	0		8
15:51:51	9	77.6	3	0		9
15:52:11	10	67.3	3	0		10
15:52:31	9	70.6	3	0		11
15:52:51	12	78	3	0		12
15:53:11	11	85.6	3	0	End	13
15:53:31	7	81.3	3	0		14
15:53:51	7	79.6	3	0		15
15:54:11	8	49.3	0	0		16
15:54:31	11	34	0	0		17
15:54:51	11	19	0	0		
15:55:11	10	16.6	0	0		
15:55:31	11	21.6	0	0		
15:55:51	11	20.6	0	0		

16:17:12	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	875					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
16:01:11	4	4.6	0	0		
16:01:31	3	5.3	0	0		
16:01:51	5	11.3	0	0		
16:02:11	4	5	0	0		
16:02:31	2	2	0	0		
16:02:51	4	3.3	0	0		
16:03:11	5	5.6	0	0		
16:03:31	5	5	0	0		
16:03:51	5	6	0	0		
16:04:11	3	4	0	0		
16:04:31	4	5	0	0		
16:04:51	8	12	0	0		
16:05:11	8	10.3	0	0		
16:05:31	4	5.6	0	0		
16:05:51	4	5	0	0		
16:06:11	7	27.6	0	0		
16:06:31	3	26.3	5	0		
16:06:51	7	33	0	0		
16:07:11	4	16	0	0		
16:07:31	3	20.3	5	3		
16:07:51	6	37.3	0	0		
16:08:11	6	38.3	0	0		
16:08:31	7	33.3	0	0		
16:08:51	6	29	0	0	Vol20>17	
16:09:11	6	12	0	0	Start	
16:09:31	5	7.3	0	0		
16:09:51	4	4.6	0	0		
16:10:11	10	27.6	0	0		
16:10:31	22	37.6	1	1		1
16:10:51	20	50	1	1		2
16:11:11	20	45.3	1	1		3
16:11:31	22	39	1	1		4
16:11:51	19	33.6	1	1	End	5
16:12:11	21	30.6	1	1		6
16:12:31	25	39.3	1	1		7
16:12:51	21	39.6	1	1		8
16:13:11	7	10.6	0	0		
16:13:31	6	7	0	0		
16:13:51	1	1.3	0	0		
16:14:11	4	8.3	0	0		
16:14:31	5	6.6	0	0		
16:14:51	5	6.3	0	0		
16:15:11	11	13.6	0	0		
16:15:31	3	7.3	0	0		
16:15:51	8	13	0	0		

16:17:18	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	876					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
16:01:11	2	2	0	0		
16:01:31	8	12.6	0	0		
16:01:51	8	11.6	0	0	Pulse	
16:02:11	7	11.6	0	0	Start	
16:02:31	4	4.6	0	0		
16:02:51	1	0.3	2	2		
16:03:11	1	35.6	5	3		
16:03:31	3	2	2	2		1
16:03:51	6	4	2	2		2
16:04:11	4	2.6	2	2		3
16:04:31	3	2	2	2		4
16:04:51	3	2	2	2		5
16:05:11	6	4	2	2		6
16:05:31	6	4	2	2		7
16:05:51	2	1.3	2	2		8
16:06:11	6	4	2	2		9
16:06:31	2	1.3	2	2		10
16:06:51	4	2.6	2	2		11
16:07:11	4	2.6	2	2		12
16:07:31	5	3.3	2	2		13
16:07:51	6	4	2	2		14
16:08:11	6	4	2	2		15
16:08:31	6	3.6	2	2		16
16:08:51	8	5.3	2	2		17
16:09:11	3	2.3	2	0		18
16:09:31	5	3.3	2	2		19
16:09:51	1	0.6	2	2		20
16:10:11	4	3	2	0		21
16:10:31	2	1.3	2	2		22
16:10:51	8	5.3	2	2		23
16:11:11	6	4	2	2		24
16:11:31	6	3.6	2	2		25
16:11:51	5	3.6	2	2	End	26
16:12:11	7	4.6	2	2		27
16:12:31	4	2.6	2	2		28
16:12:51	4	2.6	2	2		29
16:13:11	10	9	2	2		30
16:13:31	8	9.3	0	0		
16:13:51	2	4.6	0	0		
16:14:11	8	9.3	0	0		
16:14:31	11	12.3	0	0		
16:14:51	8	9.3	0	0		
16:15:11	11	12.3	0	0		
16:15:31	5	5.3	0	0		
16:15:51	10	13	0	0		

16:17:24	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	877					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
16:01:11	2	1.6	0	0		
16:01:31	11	10.3	2	0		
16:01:51	10	9.3	0	0	Sens to (1)	
16:02:11	8	8.3	0	0	Start	
16:02:31	3	3	0	0	??? effect	
16:02:51	0	0	0	0		
16:03:11	3	36.6	5	0		
16:03:31	8	7	0	0		1
16:03:51	4	3.6	0	0		2
16:04:11	9	9.6	0	0		3
16:04:31	3	2.6	0	0		4
16:04:51	8	8.3	0	0		5
16:05:11	9	8.3	0	0		6
16:05:31	12	10.6	2	2		7
16:05:51	3	2.6	0	0		8
16:06:11	12	12.6	0	0		9
16:06:31	2	2	0	0		10
16:06:51	8	7	0	0		11
16:07:11	13	11.6	2	2		12
16:07:31	10	9	2	2		13
16:07:51	9	7	2	0		14
16:08:11	14	12.6	2	2		15
16:08:31	13	12.3	2	0		16
16:08:51	10	10.3	0	0		17
16:09:11	5	4.3	0	0		18
16:09:31	7	6	0	0		19
16:09:51	10	9.3	0	0		20
16:10:11	7	6.3	0	0		21
16:10:31	12	10.3	2	2		22
16:10:51	14	13.6	2	0		23
16:11:11	11	9.6	2	2		24
16:11:31	12	11	2	0		25
16:11:51	10	8	2	2	End	26
16:12:11	9	8.3	0	0		27
16:12:31	9	8.3	0	0		28
16:12:51	7	8	0	0		29
16:13:11	9	8	2	2		30
16:13:31	4	3.6	0	0		
16:13:51	1	1	0	0		
16:14:11	6	6.6	0	0		
16:14:31	14	14.6	2	0		
16:14:51	9	9.3	0	0		
16:15:11	12	12.6	0	0		
16:15:31	2	2.6	0	0		
16:15:51	12	12.6	0	0		

16:17:30	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	878					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
16:01:11	10	16.3	0	0		
16:01:31	9	13.3	0	0		
16:01:51	8	11	0	0	Sens to (1)	
16:02:11	6	9.6	0	0	Start	1
16:02:31	8	11	0	0	??? effect	2
16:02:51	0	0	0	0		3
16:03:11	7	41.3	0	0		4
16:03:31	7	7.3	0	0		5
16:03:51	6	6.6	0	0		6
16:04:11	9	10.3	0	0		7
16:04:31	10	11.3	0	0		8
16:04:51	11	12.3	0	0		9
16:05:11	6	6.6	0	0		10
16:05:31	4	4.3	0	0		11
16:05:51	8	9.6	0	0		12
16:06:11	8	8.6	0	0		13
16:06:31	9	11.3	0	0		14
16:06:51	9	11.3	0	0		15
16:07:11	13	17.6	0	0		16
16:07:31	6	7	0	0		17
16:07:51	8	10.6	0	0		18
16:08:11	9	11.6	0	0		19
16:08:31	8	10.6	0	0		20
16:08:51	8	11	0	0		21
16:09:11	9	12	0	0		22
16:09:31	7	7.6	0	0		23
16:09:51	6	7.3	0	0		24
16:10:11	9	10	0	0		25
16:10:31	12	12.6	0	0		26
16:10:51	6	5.3	0	0		27
16:11:11	5	6.6	0	0		28
16:11:31	13	14.6	0	0		29
16:11:51	7	8	0	0		30
16:12:11	6	6	0	0		31
16:12:31	9	9	0	0	End	32
16:12:51	9	9	0	0		
16:13:11	7	10	0	0		
16:13:31	4	8	0	0		
16:13:51	7	9.6	0	0		
16:14:11	9	12.6	0	0		
16:14:31	9	11.6	0	0		
16:14:51	10	13.3	0	0		
16:15:11	6	7	0	0		
16:15:31	8	10.3	0	0		
16:15:51	5	9.3	0	0		

16:17:37	9/12/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	879					
TUESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
16:01:11	8	10.3	0	0		
16:01:31	10	14.6	0	0		
16:01:51	10	14.6	0	0	Pulse	
16:02:11	13	15.6	0	0	Start	
16:02:31	4	4.6	0	0		
16:02:51	0	0	0	0		
16:03:11	9	5.6	2	2		1
16:03:31	6	4	2	2		2
16:03:51	6	4	2	2		3
16:04:11	9	6	2	2		4
16:04:31	6	4	2	2		5
16:04:51	5	3.3	2	2		6
16:05:11	13	8.6	2	2		7
16:05:31	3	2	2	2		8
16:05:51	7	4.6	2	2		9
16:06:11	7	4.6	2	2		10
16:06:31	8	5.3	2	2		11
16:06:51	7	4.6	2	2		12
16:07:11	5	3.3	2	2		13
16:07:31	4	2.6	2	2		14
16:07:51	6	4	2	2		15
16:08:11	9	6	2	2		16
16:08:31	9	6	2	2		17
16:08:51	4	2.6	2	2		18
16:09:11	6	4	2	2		19
16:09:31	7	4.6	2	2		20
16:09:51	2	1.3	2	2		21
16:10:11	2	1.3	2	2		22
16:10:31	8	5.3	2	2		23
16:10:51	5	3.3	2	2		24
16:11:11	3	1.6	2	2		25
16:11:31	10	7	2	2		26
16:11:51	7	4.6	2	2		27
16:12:11	10	6.6	2	2	End	28
16:12:31	10	6.6	2	2		29
16:12:51	9	6	2	2		30
16:13:11	9	10.6	0	0		
16:13:31	9	10.6	0	0		
16:13:51	13	18.3	0	0		
16:14:11	14	20.6	0	0		
16:14:31	11	15	0	0		
16:14:51	10	13.3	0	0		
16:15:11	9	12	0	0		
16:15:31	9	11	0	0		
16:15:51	11	16	0	0		

8:57:12	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	875					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:41:11	5	8.3	0	0		
8:41:31	7	12.3	0	0		
8:41:51	6	11.3	0	0		
8:42:11	6	8	0	0		
8:42:31	6	8.3	0	0		
8:42:51	10	17.6	0	0		
8:43:11	10	19	0	0		
8:43:31	8	15	0	0		
8:43:51	7	11.6	0	0		
8:44:11	14	22.6	0	0		
8:44:31	10	17	0	0		
8:44:51	5	7.3	0	0		
8:45:11	10	14.6	0	0		
8:45:31	12	27.6	0	0		
8:45:51	4	5.6	0	0		
8:46:11	7	9	0	0		
8:46:31	9	12.3	0	0		
8:46:51	7	13.3	0	0		
8:47:11	7	13	0	0		
8:47:31	8	15	0	0		
8:47:51	6	12	0	0		
8:48:11	8	17.6	0	0		
8:48:31	8	24	0	0		
8:48:51	7	18.3	0	0	Sens to (1)	
8:49:11	10	23.6	0	0	Start	1
8:49:31	10	22.3	0	0	??? effect	2
8:49:51	7	14.3	0	0		3
8:50:11	2	38	5	0		4
8:50:31	10	13.6	0	0		5
8:50:51	8	11	0	0		6
8:51:11	6	9.3	0	0		7
8:51:31	10	12	0	0		8
8:51:51	12	13	0	0		9
8:52:11	7	7.6	0	0		10
8:52:31	8	9.3	0	0		11
8:52:51	11	17.3	0	0		12
8:53:11	5	5.3	0	0		13
8:53:31	6	6.3	0	0		14
8:53:51	11	14.3	0	0	End	15
8:54:11	5	8.6	0	0		
8:54:31	5	6.3	0	0		
8:54:51	3	8.3	0	0		
8:55:11	7	10.3	0	0		
8:55:31	10	18	0	0		
8:55:51	4	8	0	0		

8:57:24	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	877					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:41:11	6	11.3	0	0		
8:41:31	7	19.6	0	0		
8:41:51	5	33.3	0	0		
8:42:11	11	39.3	0	0		
8:42:31	11	23.6	0	0		
8:42:51	13	21.6	0	0		
8:43:11	16	26	0	0		
8:43:31	12	15.3	0	0		
8:43:51	16	19.3	0	0		
8:44:11	16	23	0	0		
8:44:31	15	19.6	0	0		
8:44:51	11	15	0	0		
8:45:11	12	19	0	0		
8:45:31	15	27.6	0	0		
8:45:51	13	20.6	0	0		
8:46:11	15	21.3	0	0		
8:46:31	12	17	0	0		
8:46:51	8	13.6	0	0		
8:47:11	10	26	0	0		
8:47:31	13	32	0	0		
8:47:51	11	27	0	0		
8:48:11	8	35	0	0		
8:48:31	9	41	0	0		
8:48:51	11	30.6	0	0		
8:49:11	10	29	0	0		
8:49:31	12	32	0	0	Pulse	
8:49:51	6	14.6	0	0	Start	
8:50:11	1	37.3	5	3		
8:50:31	6	4	2	2		1
8:50:51	8	5.3	2	2		2
8:51:11	11	7	2	2		3
8:51:31	4	3	2	0		4
8:51:51	12	8	2	2		5
8:52:11	7	4.3	2	2		6
8:52:31	6	4.3	2	2		7
8:52:51	9	6	2	2		8
8:53:11	13	8.6	2	2		9
8:53:31	0	0	0	0		
8:53:51	5	3.3	2	2	End	10
8:54:11	5	3.3	2	2		11
8:54:31	6	4	2	2		12
8:54:51	9	6	2	2		13
8:55:11	9	24	0	0		
8:55:31	7	25	0	0		
8:55:51	10	17.6	0	0		

8:57:30	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	878					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:41:11	8	14	0	0		
8:41:31	6	6.3	0	0		
8:41:51	3	4.3	0	0		
8:42:11	8	10.6	0	0		
8:42:31	6	6.6	0	0		
8:42:51	3	3.3	0	0		
8:43:11	6	7	0	0		
8:43:31	5	8.6	0	0		
8:43:51	7	8.3	0	0		
8:44:11	3	3.6	0	0		
8:44:31	6	7	0	0		
8:44:51	10	11.3	0	0		
8:45:11	4	6.6	0	0		
8:45:31	5	5	0	0		
8:45:51	6	8.6	0	0		
8:46:11	5	6	0	0		
8:46:31	8	9.6	0	0		
8:46:51	3	7.3	0	0		
8:47:11	7	9.6	0	0		
8:47:31	5	8.3	0	0		
8:47:51	4	8	0	0		
8:48:11	10	13.3	0	0		
8:48:31	8	12.3	0	0		
8:48:51	8	9.3	0	0	Sens to (1)	
8:49:11	5	6	0	0	Start	1
8:49:31	5	9	0	0	??? effect	2
8:49:51	0	0	0	0		3
8:50:11	2	37.3	5	0		4
8:50:31	5	5.3	0	0		5
8:50:51	3	3.3	0	0		6
8:51:11	5	5	0	0		7
8:51:31	6	6	0	0		8
8:51:51	7	6.6	0	0		9
8:52:11	6	6	0	0		10
8:52:31	5	5.3	0	0		11
8:52:51	4	4.3	0	0		12
8:53:11	7	8	0	0		13
8:53:31	7	10	0	0		14
8:53:51	6	6.3	0	0		15
8:54:11	5	7.6	0	0	End	16
8:54:31	7	11.6	0	0		
8:54:51	10	15	0	0		
8:55:11	6	6	0	0		
8:55:31	4	4.6	0	0		
8:55:51	6	6.3	0	0		

8:57:36	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	879					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:41:11	7	10.3	0	0		
8:41:31	7	7.3	0	0		
8:41:51	4	4	0	0		
8:42:11	7	7.3	0	0		
8:42:31	3	3.3	0	0		
8:42:51	4	4.6	0	0		
8:43:11	6	8.3	0	0		
8:43:31	8	9.3	0	0		
8:43:51	8	9.3	0	0		
8:44:11	4	4	0	0		
8:44:31	7	7.6	0	0		
8:44:51	8	9	0	0		
8:45:11	3	3	0	0		
8:45:31	9	10	0	0		
8:45:51	8	9.6	0	0		
8:46:11	6	6.6	0	0		
8:46:31	9	10	0	0		
8:46:51	4	4	0	0		
8:47:11	12	13.6	0	0		
8:47:31	7	7.6	0	0		
8:47:51	6	6.3	0	0		
8:48:11	8	11	0	0		
8:48:31	4	4.6	0	0		
8:48:51	3	3.3	0	0	Sens to (6)	
8:49:11	10	10.3	0	0	Start	
8:49:31	7	7.6	0	0		
8:49:51	2	2	0	0		
8:50:11	3	2	2	2		
8:50:31	0	54.3	5	3		1
8:50:51	5	52.3	0	0		2
8:51:11	1	92.3	5	3		3
8:51:31	2	30.3	5	3		4
8:51:51	2	51.3	5	0		5
8:52:11	3	56.3	0	0		6
8:52:31	2	47.6	5	0		7
8:52:51	3	61	0	0		8
8:53:11	2	75.3	5	3		9
8:53:31	1	86.3	5	3		10
8:53:51	4	56.3	0	0		11
8:54:11	2	80.3	5	3	End	12
8:54:31	3	62	0	0		13
8:54:51	7	40	0	0		14
8:55:11	4	13.3	0	0		
8:55:31	4	4.3	0	0		
8:55:51	4	4.3	0	0		

8:57:42	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	880					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
8:41:11	8	8.3	0	0		
8:41:31	3	2.6	0	0		
8:41:51	1	0.6	2	2		
8:42:11	3	3.3	0	0		
8:42:31	2	2.3	0	0		
8:42:51	0	0	0	0		
8:43:11	5	7	0	0		
8:43:31	5	4.3	0	0		
8:43:51	3	2.6	0	0		
8:44:11	1	1	0	0		
8:44:31	0	0	0	0		
8:44:51	2	1.6	0	0		
8:45:11	0	0	0	0		
8:45:31	1	1	0	0		
8:45:51	0	0	0	0		
8:46:11	1	1	0	0		
8:46:31	4	4	0	0		
8:46:51	2	2	0	0		
8:47:11	1	1	0	0		
8:47:31	5	4.6	0	0		
8:47:51	4	4.3	0	0		
8:48:11	8	9	0	0		
8:48:31	1	1	0	0		
8:48:51	3	3.6	0	0		
8:49:11	8	8	0	0		
8:49:31	4	4.3	0	0		
8:49:51	0	0	0	0		
8:50:11	0	0	0	0		
8:50:31	0	0	0	0	Pulse	
8:50:51	3	2	2	2	Start	1
8:51:11	1	0.6	2	2		2
8:51:31	1	0.6	2	2		3
8:51:51	0	0	0	0		4
8:52:11	1	0.6	2	2		5
8:52:31	0	0	0	0		6
8:52:51	3	2	2	2		7
8:53:11	4	2.6	2	2		8
8:53:31	2	1.3	2	2		9
8:53:51	2	1.3	2	2		10
8:54:11	3	2	2	2	End	11
8:54:31	2	1.3	2	2		
8:54:51	1	0.6	2	2		
8:55:11	0	0	0	0		
8:55:31	1	1	0	0		
8:55:51	2	2	0	0		

9:16:09	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	910					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
9:01:11	12	13	0	0		
9:01:31	11	12.6	0	0		
9:01:51	7	12.3	0	0		
9:02:11	13	15.6	0	0		
9:02:31	12	15	0	0		
9:02:51	5	10.3	0	0		
9:03:11	9	11	0	0		
9:03:31	4	5	0	0		
9:03:51	5	8	0	0	Vol20>17	
9:04:11	11	13.3	0	0	Start	
9:04:31	5	8.3	0	0		
9:04:51	19	49	1	1		1
9:05:11	20	51	1	1		2
9:05:31	19	41.6	1	1		3
9:05:51	19	45	1	1		4
9:06:11	21	46.6	1	1		5
9:06:31	18	50.3	1	1		6
9:06:51	20	49	1	1		7
9:07:11	22	45.6	1	1		8
9:07:31	23	31.6	1	1		9
9:07:51	22	47.6	1	1		10
9:08:11	21	31.6	1	1		11
9:08:31	24	33	1	1		12
9:08:51	20	26	1	1		13
9:09:11	7	7.3	0	0	Long hits	
9:09:31	5	6.6	0	0		
9:09:51	8	13	0	0		
9:10:11	10	38.3	0	0		1
9:10:31	5	15.6	0	0		2
9:10:51	5	20.3	0	0		3
9:11:11	4	12.6	0	0		4
9:11:31	8	28	0	0		5
9:11:51	8	31.6	0	0		6
9:12:11	3	11.6	5	0		7
9:12:31	6	22.6	0	0		8
9:12:51	9	34.3	0	0		9
9:13:11	6	37.6	0	0	End	10
9:13:31	5	20.3	0	0		11
9:13:51	5	25.3	0	3		12
9:14:11	10	12.6	0	0		
9:14:31	5	7.3	0	0		
9:14:51	9	14.6	0	0		
9:15:11	7	9	0	0		
9:15:31	6	6.6	0	0		
9:15:51	9	10.6	0	0		

9:16:15	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	911					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
9:01:11	11	12	0	0		
9:01:31	7	8	0	0		
9:01:51	8	9.3	0	0		
9:02:11	11	12.6	0	0		
9:02:31	11	11.3	0	0		
9:02:51	10	11.6	0	0	Pulse	
9:03:11	9	14	0	0	Start	
9:03:31	6	7	0	0		
9:03:51	9	11	0	0		
9:04:11	0	0	0	0		
9:04:31	5	40.3	0	0		
9:04:51	4	2.6	2	2		1
9:05:11	4	2.6	2	2		2
9:05:31	6	4	2	2		3
9:05:51	5	3.3	2	2		4
9:06:11	7	4.6	2	2		5
9:06:31	4	2.6	2	2		6
9:06:51	4	2.6	2	2		7
9:07:11	4	2.6	2	2		8
9:07:31	5	3.3	2	2		9
9:07:51	5	3.3	2	2		10
9:08:11	4	2.6	2	2		11
9:08:31	3	2	2	2		12
9:08:51	5	3.3	2	2		13
9:09:11	5	3.3	2	2		14
9:09:31	7	4.6	2	2		15
9:09:51	5	3.3	2	2		16
9:10:11	7	4.6	2	2		17
9:10:31	4	2.6	2	2		18
9:10:51	2	1.3	2	2		19
9:11:11	4	2.6	2	2		20
9:11:31	4	2.6	2	2		21
9:11:51	4	2.6	2	2		22
9:12:11	3	2	2	2		23
9:12:31	4	2.6	2	2		24
9:12:51	5	3.3	2	2		25
9:13:11	7	4.6	2	2	End	26
9:13:31	2	1.3	2	2		27
9:13:51	6	4	2	2		28
9:14:11	7	7.3	0	0		
9:14:31	7	8	0	0		
9:14:51	7	7.6	0	0		
9:15:11	10	12.3	0	0		
9:15:31	9	8.6	0	0		
9:15:51	10	11.6	0	0		

9:16:33	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	914					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
9:01:11	3	4	0	0		
9:01:31	5	5.3	0	0		
9:01:51	6	7.3	0	0		
9:02:11	4	7.3	0	0		
9:02:31	7	10.6	0	0		
9:02:51	8	9	0	0	Sens to (1)	
9:03:11	8	9.3	0	0	Start	1
9:03:31	5	5.3	0	0	??? effect	2
9:03:51	3	4	0	0		3
9:04:11	0	0	0	0		4
9:04:31	6	43.3	0	0		5
9:04:51	5	6.3	0	0		6
9:05:11	9	10.6	0	0		7
9:05:31	6	8	0	0		8
9:05:51	2	2	0	0		9
9:06:11	8	8	0	0		10
9:06:31	6	6.3	0	0		11
9:06:51	8	10	0	0		12
9:07:11	6	5.6	0	0		13
9:07:31	5	5.6	0	0		14
9:07:51	5	5	0	0		15
9:08:11	3	2.6	0	0		16
9:08:31	5	5.6	0	0		17
9:08:51	8	7.3	0	0		18
9:09:11	4	4	0	0		19
9:09:31	4	4.3	0	0		20
9:09:51	7	10.6	0	0		21
9:10:11	8	9	0	0		22
9:10:31	6	5.3	0	0		23
9:10:51	5	5	0	0		24
9:11:11	10	10.3	0	0		25
9:11:31	5	5	0	0		26
9:11:51	4	5	0	0		27
9:12:11	5	4.6	0	0		28
9:12:31	5	7.3	0	0		29
9:12:51	2	1.6	0	0	End	30
9:13:11	5	5	0	0		
9:13:31	8	8.3	0	0		
9:13:51	5	8.3	0	0		
9:14:11	4	4	0	0		
9:14:31	8	9	0	0		
9:14:51	5	9.3	0	0		
9:15:11	6	12	0	0		
9:15:31	3	4	0	0		
9:15:51	4	5.6	0	0		

9:16:39	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	915					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
9:01:11	5	5.3	0	0		
9:01:31	4	4.3	0	0		
9:01:51	7	8.6	0	0		
9:02:11	5	5.6	0	0		
9:02:31	8	8.6	0	0		
9:02:51	6	6	0	0		
9:03:11	11	11.6	0	0	Pulse	
9:03:31	5	5.6	0	0	Start	
9:03:51	6	10.3	0	0		
9:04:11	5	5.6	0	0		
9:04:31	3	39.3	5	0		
9:04:51	2	1.3	2	2		1
9:05:11	6	4	2	2		2
9:05:31	4	2.6	2	2		3
9:05:51	1	0.6	2	2		4
9:06:11	6	4	2	2		5
9:06:31	4	2.6	2	2		6
9:06:51	2	1.3	2	2		7
9:07:11	1	0.6	2	2		8
9:07:31	2	1.3	2	2		9
9:07:51	6	4	2	2		10
9:08:11	2	1.3	2	2		11
9:08:31	6	4	2	2		12
9:08:51	3	2	2	2		13
9:09:11	3	2	2	2		14
9:09:31	0	0	0	0		15
9:09:51	4	2.6	2	2		16
9:10:11	7	4.6	2	2		17
9:10:31	5	3.3	2	2		18
9:10:51	8	5.3	2	2		19
9:11:11	1	0.6	2	2		20
9:11:31	3	2	2	2		21
9:11:51	2	1.3	2	2		22
9:12:11	3	2	2	2		23
9:12:31	3	2	2	2		24
9:12:51	2	1.3	2	2		25
9:13:11	1	0.6	2	2	End	26
9:13:31	4	2.6	2	2		27
9:13:51	5	3.3	2	2		28
9:14:11	3	2	2	2		
9:14:31	10	11	0	0		
9:14:51	5	5	0	0		
9:15:11	8	10	0	0		
9:15:31	5	5.3	0	0		
9:15:51	9	9.6	0	0		

9:16:45	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	916					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
9:01:11	6	6	0	0		
9:01:31	0	0	0	0		
9:01:51	1	0.6	2	2		
9:02:11	2	1.6	0	0		
9:02:31	7	8.6	0	0		
9:02:51	5	6.6	0	0	Sens to (7)	
9:03:11	3	2.3	2	0	Start	1
9:03:31	5	4.6	0	0		2
9:03:51	1	1.3	0	0		3
9:04:11	1	1	0	0		4
9:04:31	1	38	5	3		5
9:04:51	0	0	0	0		
9:05:11	0	0	0	0		
9:05:31	0	0	0	0		
9:05:51	0	0	0	0		
9:06:11	0	0	0	0		
9:06:31	0	0	0	0		
9:06:51	0	0	0	0		
9:07:11	0	0	0	0		
9:07:31	0	0	0	0		
9:07:51	0	0	0	0		
9:08:11	0	0	0	0		
9:08:31	1	0.6	2	2		6
9:08:51	0	0	0	0		
9:09:11	1	0.6	2	2		7
9:09:31	0	0	0	0		
9:09:51	0	0	0	0		
9:10:11	2	1.3	2	2		8
9:10:31	0	0	0	0		
9:10:51	1	0.6	2	2		9
9:11:11	1	0.6	2	2		10
9:11:31	2	1.3	2	2		11
9:11:51	3	2	2	2		12
9:12:11	0	0	0	0		
9:12:31	2	1.3	2	2		13
9:12:51	0	0	0	0		
9:13:11	0	0	0	0	End	
9:13:31	1	0.6	2	2		14
9:13:51	1	0.6	2	2		15
9:14:11	2	5.3	0	0		
9:14:31	2	2.3	0	0		
9:14:51	4	4	0	0		
9:15:11	0	0	0	0		
9:15:31	4	4	0	0		
9:15:51	0	0	0	0		

15:16:09	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	910					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	2	2.3	0	0		
15:01:31	6	5.6	0	0		
15:01:51	1	0.3	2	2		
15:02:11	7	11.6	0	0		
15:02:31	5	6.6	0	0		
15:02:51	3	3.6	0	0	Pulse	
15:03:11	9	29.3	0	0	Start	
15:03:31	4	13.3	0	0		
15:03:51	0	0	0	0		
15:04:11	5	40.6	0	0		
15:04:31	2	1.3	2	2		1
15:04:51	9	6	2	2		2
15:05:11	2	1.3	2	2		3
15:05:31	8	6.3	2	0		4
15:05:51	8	5.3	2	2		5
15:06:11	2	1.3	2	2		6
15:06:31	2	1.3	2	2		7
15:06:51	5	3.3	2	2		8
15:07:11	3	2	2	2		9
15:07:31	1	0.6	2	2		10
15:07:51	3	2	2	2		11
15:08:11	2	1.3	2	2		12
15:08:31	6	4	2	2		13
15:08:51	7	4.6	2	2		14
15:09:11	2	1.3	2	2		15
15:09:31	4	2.6	2	2		16
15:09:51	4	2.6	2	2		17
15:10:11	4	2.6	2	2		18
15:10:31	4	2.6	2	2		19
15:10:51	3	2	2	2		20
15:11:11	3	2	2	2		21
15:11:31	5	3.3	2	2		22
15:11:51	5	3.3	2	2		23
15:12:11	8	5.3	2	2		24
15:12:31	1	0.6	2	2		25
15:12:51	1	0.6	2	2	End	26
15:13:11	6	4	2	2		27
15:13:31	5	3.3	2	2		28
15:13:51	3	2	2	2		29
15:14:11	5	7	0	0		
15:14:31	9	10.3	0	0		
15:14:51	7	8.3	0	0		
15:15:11	8	16.6	0	0		
15:15:31	5	5.3	0	0		
15:15:51	8	9.3	0	0		

15:16:15	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	911					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	8	8.6	0	0		
15:01:31	8	7.6	0	0		
15:01:51	8	7.6	0	0		
15:02:11	8	11.6	0	0		
15:02:31	8	9.6	0	0		
15:02:51	10	12.6	0	0	Sens to (1)	
15:03:11	13	19	0	0	Start	1
15:03:31	7	19.6	0	0	??? effect	2
15:03:51	1	1	0	0		3
15:04:11	4	43.3	0	0		4
15:04:31	11	11.6	0	0		5
15:04:51	13	17	0	0		6
15:05:11	11	11.6	0	0		7
15:05:31	10	10.3	0	0		8
15:05:51	7	7.6	0	0		9
15:06:11	9	9.3	0	0		10
15:06:31	10	9.6	0	0		11
15:06:51	6	10	0	0		12
15:07:11	6	5.6	0	0		13
15:07:31	6	6	0	0		14
15:07:51	12	12.3	0	0		15
15:08:11	11	10.6	0	0		16
15:08:31	10	11	0	0		17
15:08:51	10	8.6	2	2		18
15:09:11	4	4.6	0	0		19
15:09:31	6	5.3	0	0		20
15:09:51	13	16.6	0	0		21
15:10:11	11	11	0	0		22
15:10:31	10	10.6	0	0		23
15:10:51	5	4.6	0	0		24
15:11:11	10	11	0	0		25
15:11:31	9	9	0	0		26
15:11:51	12	11.3	2	0		27
15:12:11	10	10	0	0		28
15:12:31	5	4.6	0	0		29
15:12:51	9	8	2	2	End	30
15:13:11	12	13	0	0		
15:13:31	7	6.3	0	0		
15:13:51	11	15.3	0	0		
15:14:11	8	8	0	0		
15:14:31	5	8	0	0		
15:14:51	7	8	0	0		
15:15:11	11	13	0	0		
15:15:31	8	9.3	0	0		
15:15:51	15	16	2	0		

15:16:33	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	914					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	6	7.3	0	0		
15:01:31	8	9.6	0	0		
15:01:51	9	11.6	0	0		
15:02:11	14	19	0	0		
15:02:31	9	13	0	0		
15:02:51	8	12.3	0	0	Sens to (6)	
15:03:11	8	10	0	0	Start	1
15:03:31	7	11.6	0	0	??? effect	2
15:03:51	4	4	0	0		3
15:04:11	4	44.3	0	0		4
15:04:31	7	12.6	0	0		5
15:04:51	8	20.6	0	0		6
15:05:11	10	22	0	0		7
15:05:31	14	25.3	0	0		8
15:05:51	7	13.3	0	0		9
15:06:11	7	19	0	0		10
15:06:31	9	15.3	0	0		11
15:06:51	9	12.6	0	0		12
15:07:11	7	10.6	0	0		13
15:07:31	9	16	0	0		14
15:07:51	10	15.6	0	0		15
15:08:11	8	14.6	0	0		16
15:08:31	7	12.6	0	0		17
15:08:51	7	12	0	0		18
15:09:11	7	11.6	0	0		19
15:09:31	12	20.3	0	0		20
15:09:51	13	20.3	0	0		21
15:10:11	12	24	0	0		22
15:10:31	7	13.6	0	0		23
15:10:51	9	18	0	0		24
15:11:11	13	21.3	0	0		25
15:11:31	7	10.6	0	0		26
15:11:51	10	16.3	0	0		27
15:12:11	12	23	0	0		28
15:12:31	10	17.3	0	0		29
15:12:51	10	14	0	0	End	30
15:13:11	7	14	0	0		
15:13:31	10	18.3	0	0		
15:13:51	10	16	0	0		
15:14:11	11	16	0	0		
15:14:31	7	9	0	0		
15:14:51	9	10.3	0	0		
15:15:11	12	14.3	0	0		
15:15:31	7	9.3	0	0		
15:15:51	9	11.6	0	0		

15:16:39	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	915					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	11	13.6	0	0		
15:01:31	12	12.6	0	0		
15:01:51	12	15	0	0		
15:02:11	11	14.6	0	0		
15:02:31	7	7.6	0	0		
15:02:51	8	11.3	0	0	Sens to (1)	
15:03:11	15	19	0	0	Start	1
15:03:31	8	10.3	0	0	??? effect	2
15:03:51	3	7.3	0	0		3
15:04:11	4	41	0	0		4
15:04:31	4	4.3	0	0		5
15:04:51	17	19.6	2	0		6
15:05:11	11	13.6	0	0		7
15:05:31	10	13.3	0	0		8
15:05:51	11	15.6	0	0		9
15:06:11	11	15.3	0	0		10
15:06:31	9	11	0	0		11
15:06:51	10	11	0	0		12
15:07:11	12	14.3	0	0		13
15:07:31	9	9	0	0		14
15:07:51	10	9.3	0	0		15
15:08:11	8	9	0	0		16
15:08:31	11	11.3	0	0		17
15:08:51	14	19	0	0		18
15:09:11	5	5.6	0	0		19
15:09:31	14	17.6	0	0		20
15:09:51	12	13	0	0		21
15:10:11	10	10.6	0	0		22
15:10:31	12	12	0	0		23
15:10:51	10	10.3	0	0		24
15:11:11	13	16.6	0	0		25
15:11:31	10	10	0	0		26
15:11:51	14	13.3	2	0		27
15:12:11	14	14.6	2	0		28
15:12:31	9	10.6	0	0		29
15:12:51	12	12.6	0	0		30
15:13:11	10	10.3	0	0	End	31
15:13:31	7	7.6	0	0		
15:13:51	10	10	0	0		
15:14:11	2	2	0	0		
15:14:31	0	0	0	0		
15:14:51	0	0	0	0		
15:15:11	0	0	0	0		
15:15:31	0	0	0	0		
15:15:51	0	0	0	0		

15:16:46	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	916					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:01:11	12	13.6	0	0		
15:01:31	16	20.3	0	0		
15:01:51	13	15.3	0	0		
15:02:11	14	16.6	0	0		
15:02:31	14	16	0	0		
15:02:51	5	7.6	0	0	Pulse	
15:03:11	16	18	2	0	Start	
15:03:31	12	14.3	0	0		
15:03:51	5	10	0	0		
15:04:11	4	39.6	0	0		
15:04:31	10	6.6	2	2		1
15:04:51	4	2.6	2	2		2
15:05:11	7	4.6	2	2		3
15:05:31	4	2.6	2	2		4
15:05:51	7	4.6	2	2		5
15:06:11	6	4	2	2		6
15:06:31	6	4	2	2		7
15:06:51	9	6	2	2		8
15:07:11	7	4.6	2	2		9
15:07:31	8	5	2	2		10
15:07:51	6	4.3	2	2		11
15:08:11	4	2.6	2	2		12
15:08:31	5	3.3	2	2		13
15:08:51	12	8	2	2		14
15:09:11	8	5.3	2	2		15
15:09:31	9	6	2	2		16
15:09:51	10	6.6	2	2		17
15:10:11	12	8	2	2		18
15:10:31	10	6.6	2	2		19
15:10:51	3	2	2	2		20
15:11:11	11	7.3	2	2		21
15:11:31	7	4.3	2	2		22
15:11:51	10	6.6	2	2		23
15:12:11	7	4.6	2	2		24
15:12:31	12	8	2	2		25
15:12:51	10	6.6	2	2		26
15:13:11	8	5.3	2	2	End	27
15:13:31	8	5.3	2	2		28
15:13:51	9	6	2	2		29
15:14:11	13	12.6	2	0		30
15:14:31	13	15	0	0		
15:14:51	9	9.3	0	0		
15:15:11	13	15	0	0		
15:15:31	14	16.6	0	0		
15:15:51	12	14.3	0	0		

15:36:53	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	751					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:21:11	4	4.3	0	0		
15:21:31	8	11.3	0	0		
15:21:51	12	14	0	0		
15:22:11	7	8	0	0		
15:22:31	5	5.3	0	0		
15:22:51	10	10.6	0	0		
15:23:11	9	9	0	0		
15:23:31	7	8.3	0	0		
15:23:51	10	11	0	0		
15:24:11	7	10.6	0	0		
15:24:31	6	7	0	0		
15:24:51	7	9	0	0		
15:25:11	6	6.3	0	0		
15:25:31	10	11.6	0	0		
15:25:51	6	6.3	0	0		
15:26:11	12	14	0	0		
15:26:31	10	13	0	0		
15:26:51	10	12	0	0		
15:27:11	10	14.6	0	0		
15:27:31	10	15.3	0	0		
15:27:51	6	8	0	0		
15:28:11	9	9.6	0	0		
15:28:31	6	9.3	0	0		
15:28:51	5	8.3	0	0		
15:29:11	6	6.3	0	0		
15:29:31	4	6.6	0	0		
15:29:51	8	10	0	0		
15:30:11	8	11.3	0	0	Long hits	
15:30:31	7	12.6	0	0	Start	
15:30:51	8	11.6	0	0		
15:31:11	5	6.3	0	0		
15:31:31	7	47.6	0	0		1
15:31:51	8	68.3	3	0		2
15:32:11	8	60.6	0	0		3
15:32:31	7	63	0	0		4
15:32:51	4	59.3	0	0		5
15:33:11	7	62.6	0	0		6
15:33:31	10	61.3	3	0		7
15:33:51	7	44.3	0	0	End	8
15:34:11	4	46	0	0		9
15:34:31	6	60	0	0		10
15:34:51	6	63.6	0	0		11
15:35:11	4	63.6	0	0		12
15:35:31	9	14.6	0	0		
15:35:51	5	9	0	0		

15:57:11	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	875					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	4	6	0	0		
15:41:31	6	9	0	0		
15:41:51	8	15	0	0	Pulse	
15:42:11	8	11.6	0	0	Start	
15:42:31	7	7.3	0	0		
15:42:51	1	1.6	0	0		
15:43:11	5	40	0	0		
15:43:31	7	4.6	2	2		1
15:43:51	5	3.3	2	2		2
15:44:11	2	1.3	2	2		3
15:44:31	4	2.6	2	2		4
15:44:51	5	3.3	2	2		5
15:45:11	6	4	2	2		6
15:45:31	2	1.3	2	2		7
15:45:51	3	2	2	2		8
15:46:11	5	3	2	2		9
15:46:31	2	1.6	0	0		10
15:46:51	4	2.6	2	2		11
15:47:11	2	1.3	2	2		12
15:47:31	3	2	2	2		13
15:47:51	4	2.6	2	2		14
15:48:11	4	2.6	2	2		15
15:48:31	1	0.6	2	2		16
15:48:51	4	2.6	2	2		17
15:49:11	6	4	2	2		18
15:49:31	4	2.6	2	2		19
15:49:51	7	4.6	2	2		20
15:50:11	0	0	0	0		
15:50:31	1	0.6	2	2		21
15:50:51	4	2.6	2	2		22
15:51:11	1	0.6	2	2		23
15:51:31	1	0.6	2	2		24
15:51:51	2	1.3	2	2	End	25
15:52:11	5	3.3	2	2		26
15:52:31	6	4	2	2		27
15:52:51	3	2	2	2		28
15:53:11	3	3.6	0	0		
15:53:31	7	7.3	0	0		
15:53:51	4	4.3	0	0		
15:54:11	7	8.6	0	0		
15:54:31	8	10.6	0	0		
15:54:51	3	4	0	0		
15:55:11	7	9	0	0		
15:55:31	4	5	0	0		
15:55:51	4	4.6	0	0		

15:57:17	9/13/89				
REPORT NO.	DOT-R710295-02				
DETECTOR	876				
WEDNESDAY					
END TIME	VOLUME	OCCUPANCY	NEW	OLD ACTION	
	(VEH/PERIOD)	(%)			
15:41:11	9	13.3	0	0	
15:41:31	10	14	0	0	
15:41:51	15	18	0	0 Sens to (1)	
15:42:11	9	12.3	0	0 Start	1
15:42:31	8	9	0	0 ??? effect	2
15:42:51	1	1	0	0	3
15:43:11	8	45.3	0	0	4
15:43:31	9	8.3	0	0	5
15:43:51	9	8.3	0	0	6
15:44:11	9	8.6	0	0	7
15:44:31	8	11.6	0	0	8
15:44:51	10	10	0	0	9
15:45:11	11	10.3	2	0	10
15:45:31	12	15.6	0	0	11
15:45:51	12	11.3	2	0	12
15:46:11	12	11.6	2	0	13
15:46:31	7	6.6	0	0	14
15:46:51	10	10.3	0	0	15
15:47:11	6	6.6	0	0	16
15:47:31	12	13	0	0	17
15:47:51	11	11.6	0	0	18
15:48:11	6	5.3	0	0	19
15:48:31	4	4.3	0	0	20
15:48:51	8	9	0	0	21
15:49:11	13	14.3	0	0	22
15:49:31	10	15	0	0	23
15:49:51	10	10.3	0	0	24
15:50:11	11	11	0	0	25
15:50:31	6	5.6	0	0	26
15:50:51	10	14	0	0	27
15:51:11	7	6.3	0	0	28
15:51:31	9	11.6	0	0	29
15:51:51	6	6.6	0	0 End	30
15:52:11	9	9.6	0	0	
15:52:31	7	7.3	0	0	
15:52:51	9	10	0	0	
15:53:11	6	12.6	0	0	
15:53:31	8	8	0	0	
15:53:51	8	9.6	0	0	
15:54:11	11	13	0	0	
15:54:31	15	18	0	0	
15:54:51	6	7.6	0	0	
15:55:11	9	11	0	0	
15:55:31	8	11.3	0	0	
15:55:51	6	9.3	0	0	

15:57:23	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	877					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	10	9.3	0	0		
15:41:31	12	12.6	0	0		
15:41:51	17	17	2	0		
15:42:11	13	13.3	0	0		
15:42:31	11	12.3	0	0		
15:42:51	2	2	0	0	Long hits	
15:43:11	7	46	0	0	Start	1
15:43:31	10	10.3	0	0		2
15:43:51	17	17	2	0		3
15:44:11	8	29.6	0	0		4
15:44:31	6	34.3	0	0		5
15:44:51	7	38.3	0	0		6
15:45:11	8	46	0	0		7
15:45:31	8	57	0	0		8
15:45:51	7	43	0	0		9
15:46:11	10	53	0	0		10
15:46:31	9	45.3	0	0		11
15:46:51	8	51.3	0	0		12
15:47:11	8	44	0	0	Normal	13
15:47:31	10	46	0	0		14
15:47:51	3	16.6	5	3		
15:48:11	7	9.6	0	0	Vol20>17	
15:48:31	9	9.6	0	0		
15:48:51	9	12	0	0		
15:49:11	19	48	1	1		1
15:49:31	20	36.6	1	1		2
15:49:51	17	34	0	0		3
15:50:11	23	34.3	1	1		4
15:50:31	23	34	1	1		5
15:50:51	24	29	1	1		6
15:51:11	26	32	1	1		7
15:51:31	25	35.3	1	1		8
15:51:51	23	33	1	1	End	9
15:52:11	24	30	1	1		10
15:52:31	21	21.3	1	1		11
15:52:51	33	32.6	1	1		12
15:53:11	6	6.3	0	0		
15:53:31	5	5.3	0	0		
15:53:51	8	9.3	0	0		
15:54:11	11	13.3	0	0		
15:54:31	17	18.6	2	0		
15:54:51	9	12	0	0		
15:55:11	9	9.6	0	0		
15:55:31	8	8	0	0		
15:55:51	12	13.6	0	0		

15:57:29	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	878					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	8	12.6	0	0		
15:41:31	8	10.6	0	0		
15:41:51	8	10.6	0	0	Sens to (6)	
15:42:11	10	13.3	0	0	Start	1
15:42:31	5	6	0	0		2
15:42:51	1	1	0	0		3
15:43:11	6	45.3	0	0		4
15:43:31	6	14.6	0	0		5
15:43:51	11	21	0	0		6
15:44:11	8	17.6	0	0		7
15:44:31	12	20	0	0		8
15:44:51	7	10.6	0	0		9
15:45:11	8	12.3	0	0		10
15:45:31	9	14	0	0		11
15:45:51	9	16.6	0	0		12
15:46:11	13	20.3	0	0		13
15:46:31	9	14.6	0	0		14
15:46:51	10	15.6	0	0		15
15:47:11	7	11.3	0	0		16
15:47:31	4	10	0	0		17
15:47:51	5	9.3	0	0		18
15:48:11	13	23.3	0	0		19
15:48:31	8	14.3	0	0		20
15:48:51	8	13	0	0		21
15:49:11	13	22.3	0	0		22
15:49:31	11	19.3	0	0		23
15:49:51	10	15.3	0	0		24
15:50:11	8	13.6	0	0		25
15:50:31	6	7.6	0	0		26
15:50:51	8	14.3	0	0		27
15:51:11	8	14.6	0	0		28
15:51:31	9	16.6	0	0		29
15:51:51	11	20	0	0		30
15:52:11	11	20	0	0	End	31
15:52:31	6	9.6	0	0		
15:52:51	8	14.3	0	0		
15:53:11	8	13	0	0		
15:53:31	9	14	0	0		
15:53:51	9	14.6	0	0		
15:54:11	11	15.3	0	0		
15:54:31	8	17	0	0		
15:54:51	8	23.3	0	0		
15:55:11	8	17	0	0		
15:55:31	9	14.3	0	0		
15:55:51	8	10	0	0		

15:57:36	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	879					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	7	9.6	0	0		
15:41:31	10	13	0	0		
15:41:51	12	14.3	0	0		
15:42:11	9	10	0	0		
15:42:31	7	8	0	0		
15:42:51	1	1	0	0		
15:43:11	8	8	0	0	Vol20>17	
15:43:31	12	15.6	0	0	Start	
15:43:51	14	16	0	0		
15:44:11	18	34.6	1	1		1
15:44:31	21	44	1	1		2
15:44:51	18	41.3	1	1		3
15:45:11	18	45	1	1		4
15:45:31	18	40.3	1	1		5
15:45:51	19	45	1	1		6
15:46:11	17	46.3	3	0		
15:46:31	17	45.3	3	0		
15:46:51	15	47	0	0		
15:47:11	19	44	1	1		7
15:47:31	18	44	1	1		8
15:47:51	19	43.3	1	1		9
15:48:11	12	17.3	0	0	Long hits	
15:48:31	9	10.3	0	0	Start	
15:48:51	12	13	0	0		
15:49:11	10	79.3	3	0		1
15:49:31	10	83	3	0		2
15:49:51	5	83.3	3	0		3
15:50:11	8	82.6	3	0		4
15:50:31	10	86.3	3	0		5
15:50:51	9	78	3	0		6
15:51:11	10	84	3	0		7
15:51:31	12	69.6	3	0		8
15:51:51	10	76.3	3	0		9
15:52:11	13	69.3	3	0	End	10
15:52:31	12	57.6	3	0		11
15:52:51	10	75.6	3	0		12
15:53:11	0	4.6	5	3		
15:53:31	0	0	0	0		
15:53:51	0	0	0	0		
15:54:11	0	0	0	0		
15:54:31	0	0	0	0		
15:54:51	0	0	0	0		
15:55:11	0	0	0	0		
15:55:31	0	0	0	0		
15:55:51	0	0	0	0		

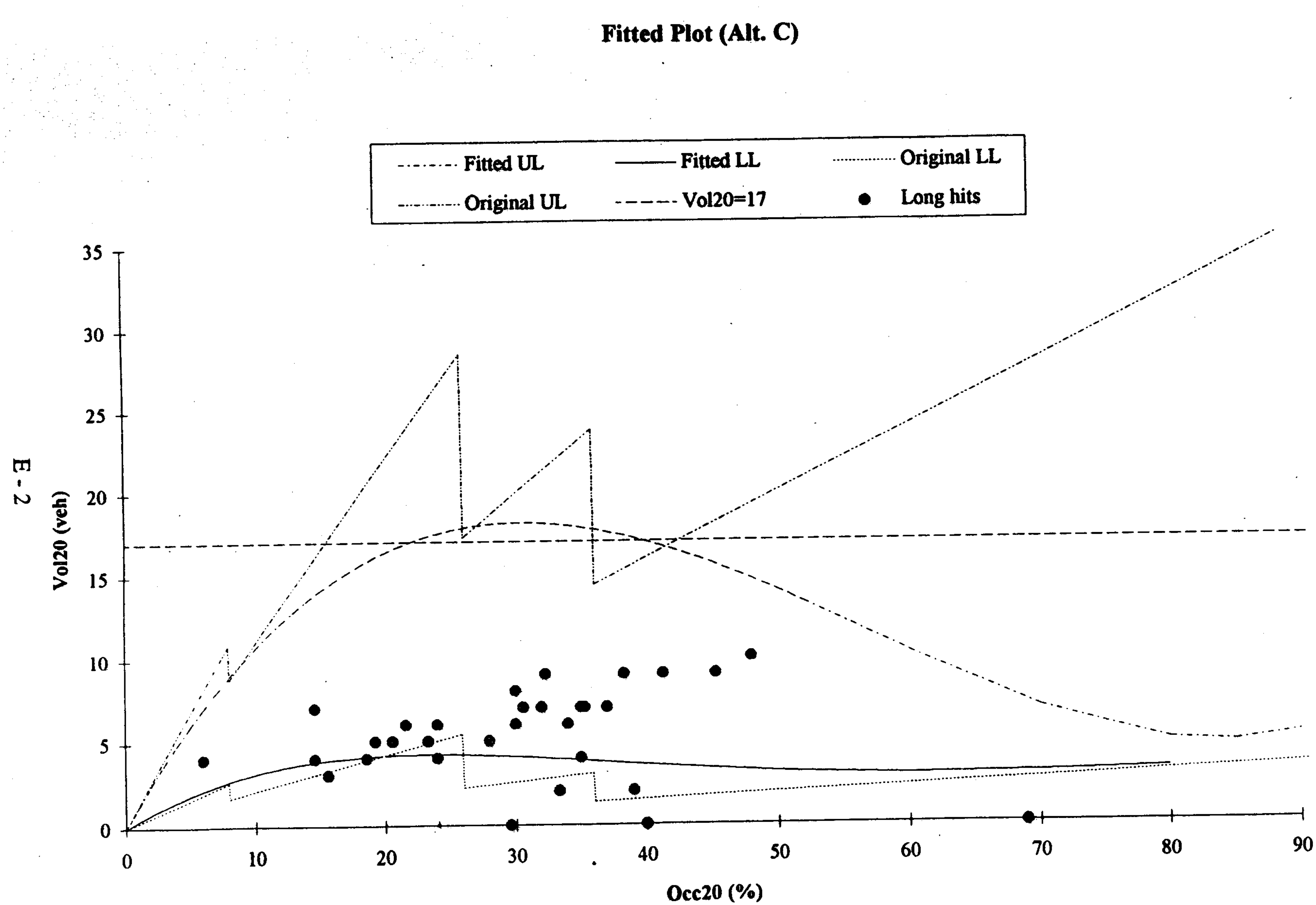
15:57:42	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	880					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
15:41:11	4	4.6	0	0		
15:41:31	10	10.6	0	0		
15:41:51	12	14	0	0	Sens to (1)	
15:42:11	8	8.6	0	0	Start	
15:42:31	8	8.6	0	0		
15:42:51	1	1	0	0		
15:43:11	7	5.6	2	0		1
15:43:31	8	7.6	0	0		2
15:43:51	12	12.3	0	0		3
15:44:11	14	14	2	0		4
15:44:31	16	15	2	0		5
15:44:51	11	9.6	2	2		6
15:45:11	7	6	0	0		7
15:45:31	9	8.6	0	0		8
15:45:51	9	9	0	0		9
15:46:11	10	10	0	0		10
15:46:31	10	10	0	0		11
15:46:51	7	7	0	0		12
15:47:11	9	9.3	0	0		13
15:47:31	6	6	0	0		14
15:47:51	10	8.3	2	2		15
15:48:11	12	11.6	2	0		16
15:48:31	10	9.6	0	0		17
15:48:51	11	10.3	2	0		18
15:49:11	8	8.6	0	0		19
15:49:31	12	11.3	2	0		20
15:49:51	8	6.6	2	0		21
15:50:11	10	9	2	2		22
15:50:31	12	10.6	2	2		23
15:50:51	10	12.3	0	0		24
15:51:11	17	17.6	2	0		25
15:51:31	14	16.3	0	0		26
15:51:51	11	11.3	0	0		27
15:52:11	10	10.6	0	0		28
15:52:31	13	13	2	0		29
15:52:51	11	12	0	0		30
15:53:11	10	11	0	0		31
15:53:31	8	8.3	0	0		32
15:53:51	9	10.6	0	0		33
15:54:11	9	11	0	0	End	34
15:54:31	13	20.3	0	0		
15:54:51	8	11.3	0	0		
15:55:11	9	17	0	0		
15:55:31	5	7.3	0	0		
15:55:51	10	15.6	0	0		

16:17:49	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	781					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD	ACTION	
	(VEH/PERIOD)	(%)				
16:01:11	7	7.7	0	0		
16:01:31	6	8.8	0	0		
16:01:51	3	3.9	0	0		
16:02:11	7	8.5	0	0		
16:02:31	8	8.4	0	0		
16:02:51	3	3.6	0	0	Vol20>17	
16:03:11	6	5.9	0	0	Start	
16:03:31	4	3	2	0		
16:03:51	0	0	0	0		
16:04:11	4	3	2	0		
16:04:31	3	3	0	0		
16:04:51	3	3.6	0	0		
16:05:11	19	51	1	1		1
16:05:31	19	42.8	1	1		2
16:05:51	23	44.8	1	1		3
16:06:11	23	36.1	1	1		4
16:06:31	26	48.5	1	1		5
16:06:51	25	37.8	1	1		6
16:07:11	28	45.1	1	1		7
16:07:31	33	41.4	1	1		8
16:07:51	25	34.4	1	1		9
16:08:11	21	35.5	1	1	Long hits	10
16:08:31	11	15.4	0	0	Start	
16:08:51	7	7	0	0		
16:09:11	5	87.7	3	0		1
16:09:31	9	76	3	0		2
16:09:51	4	18.5	5	0		3
16:10:11	3	15.6	5	3		4
16:10:31	4	23.6	5	3		5
16:10:51	4	17.8	5	0		6
16:11:11	6	30.6	0	0		7
16:11:31	4	11.8	0	0		8
16:11:51	5	21.5	0	0	End	9
16:12:11	6	22.5	0	0		10
16:12:31	7	17	0	0		11
16:12:51	7	27.2	0	0		12
16:13:11	8	11.7	0	0		
16:13:31	7	8.9	0	0		
16:13:51	6	6.5	0	0		
16:14:11	6	11.8	0	0		
16:14:31	6	7.2	0	0		
16:14:51	3	3.5	0	0		
16:15:11	6	6.3	0	0		
16:15:31	6	8.4	0	0		
16:15:51	7	7.6	0	0		

16:17:56	9/13/89					
REPORT NO.	DOT-R710295-02					
DETECTOR	782					
WEDNESDAY						
END TIME	VOLUME	OCCUPANCY	NEW	OLD		
	(VEH/PERIOD)	(%)				
16:01:11	9	11	0	0		
16:01:31	5	6	0	0		
16:01:51	7	7.3	0	0	Pulse	
16:02:11	8	14	0	0	Start	
16:02:31	9	13.2	0	0		
16:02:51	5	5.2	0	0		
16:03:11	6	5.8	0	0		
16:03:31	6	7.5	0	0		
16:03:51	1	0	4	0		
16:04:11	7	4.1	2	2		1
16:04:31	9	5.2	2	2		2
16:04:51	5	2.9	2	2		3
16:05:11	6	3.5	2	2		4
16:05:31	6	2.9	2	2		5
16:05:51	4	2.3	2	2		6
16:06:11	10	5.9	2	2		7
16:06:31	11	6.5	2	2		8
16:06:51	7	4.1	2	2		9
16:07:11	9	5.2	2	2		10
16:07:31	7	4.1	2	2		11
16:07:51	11	7	2	2		12
16:08:11	6	3	2	2		13
16:08:31	12	7	2	2		14
16:08:51	7	4.4	2	2		15
16:09:11	6	3.2	2	2		16
16:09:31	11	6.5	2	2		17
16:09:51	8	4.8	2	2		18
16:10:11	11	6.5	2	2		19
16:10:31	8	4.6	2	2		20
16:10:51	6	3.5	2	2		21
16:11:11	8	4.7	2	2		22
16:11:31	10	5.8	2	2		23
16:11:51	7	4	2	2	End	24
16:12:11	10	5.8	2	2		25
16:12:31	8	4.7	2	2		26
16:12:51	8	4.8	2	2		27
16:13:11	7	7.6	0	0		
16:13:31	6	6.1	0	0		
16:13:51	8	8.6	0	0		
16:14:11	10	12	0	0		
16:14:31	11	11.8	0	0		
16:14:51	6	5.9	0	0		
16:15:11	10	11	0	0		
16:15:31	9	9	0	0		
16:15:51	8	10	0	0		

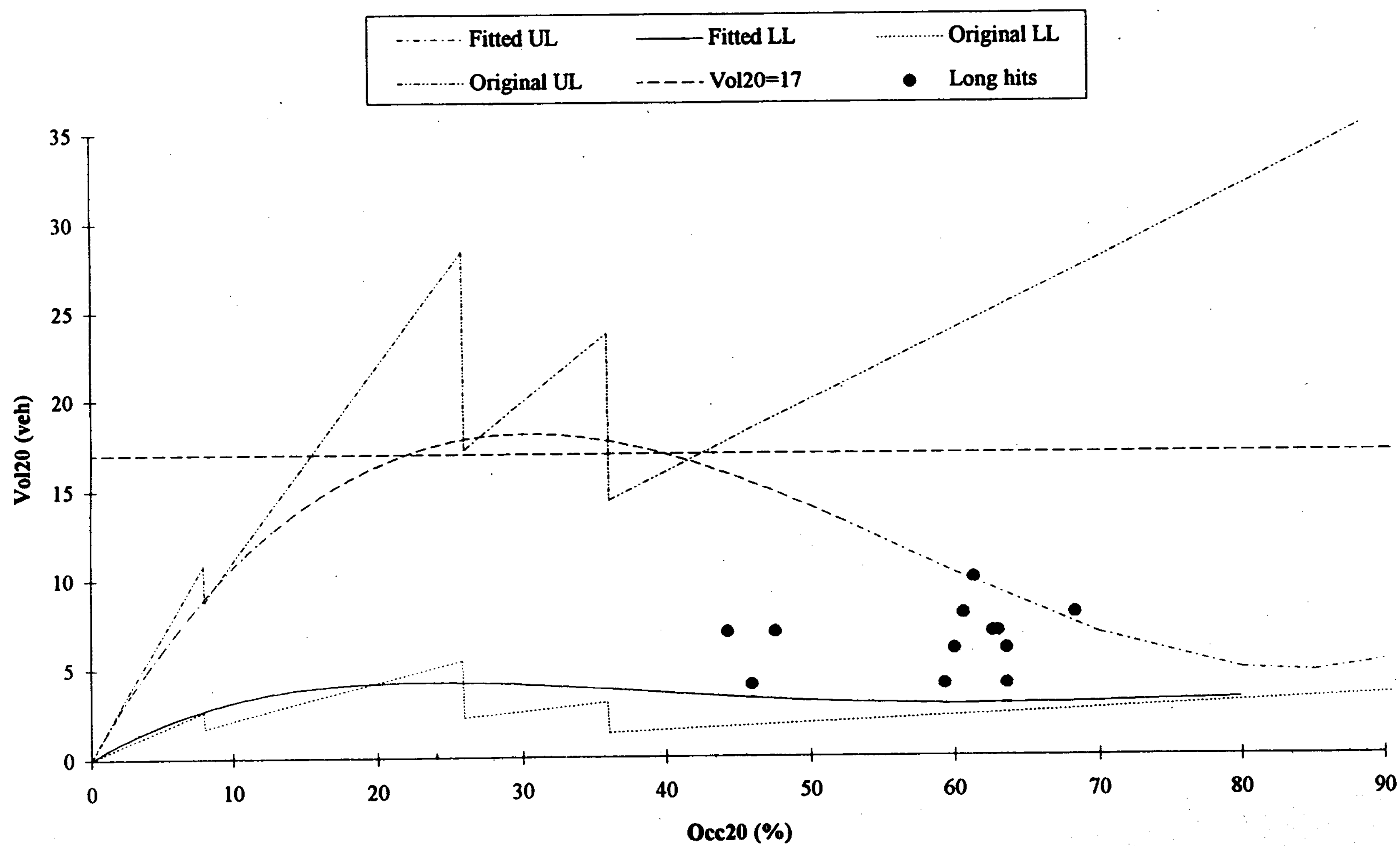
Appendix E Graphical Representation Of Hanging-On Errors

9/12, Det# 910, Longhits, N 130 SB, 15:16, Center right, 2.04% grade

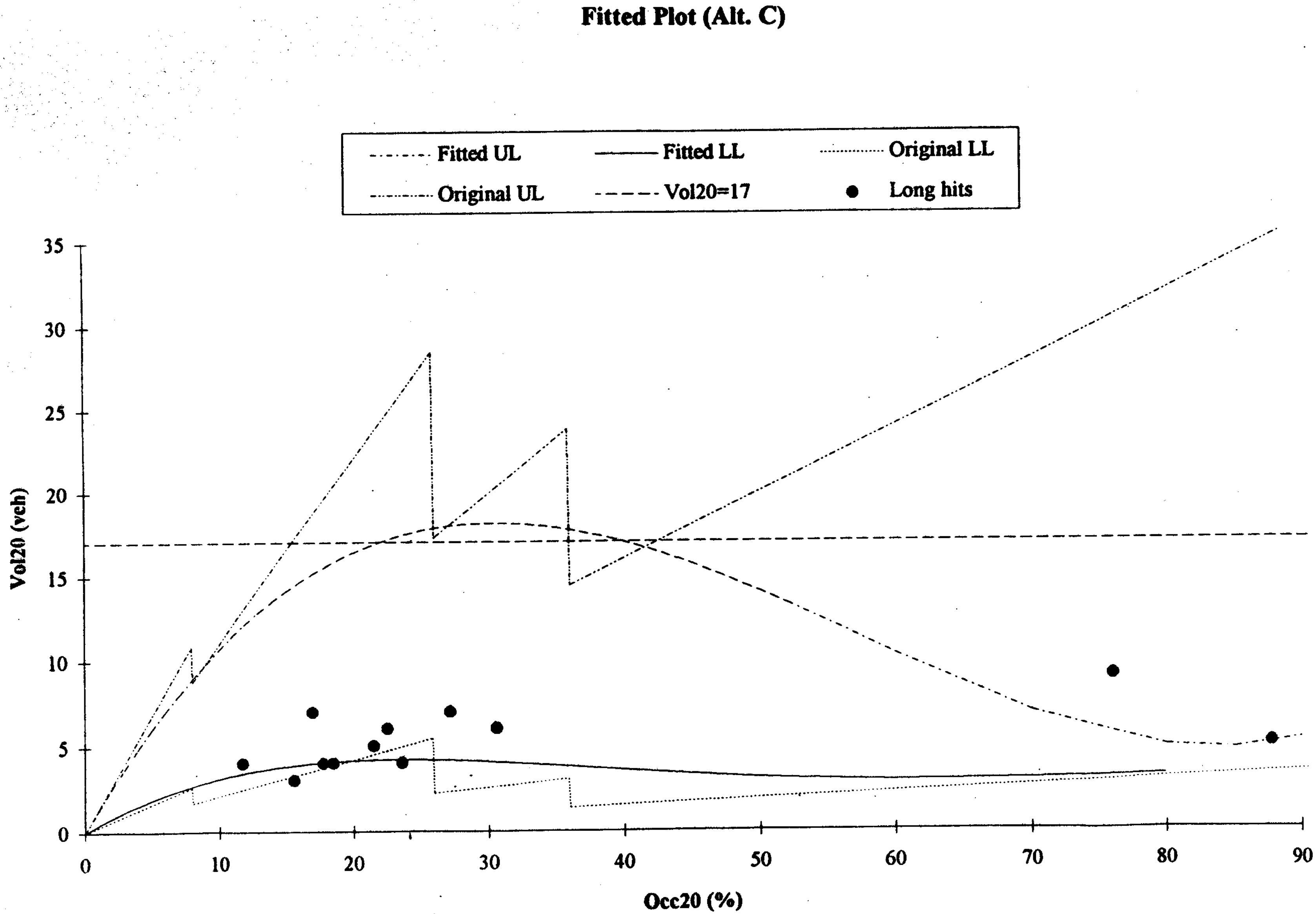


9/13, Det# 751, Longhits, 244 SW NB, 15:36, shoulder, 2.86% grade

Fitted Plot (Alt. C)

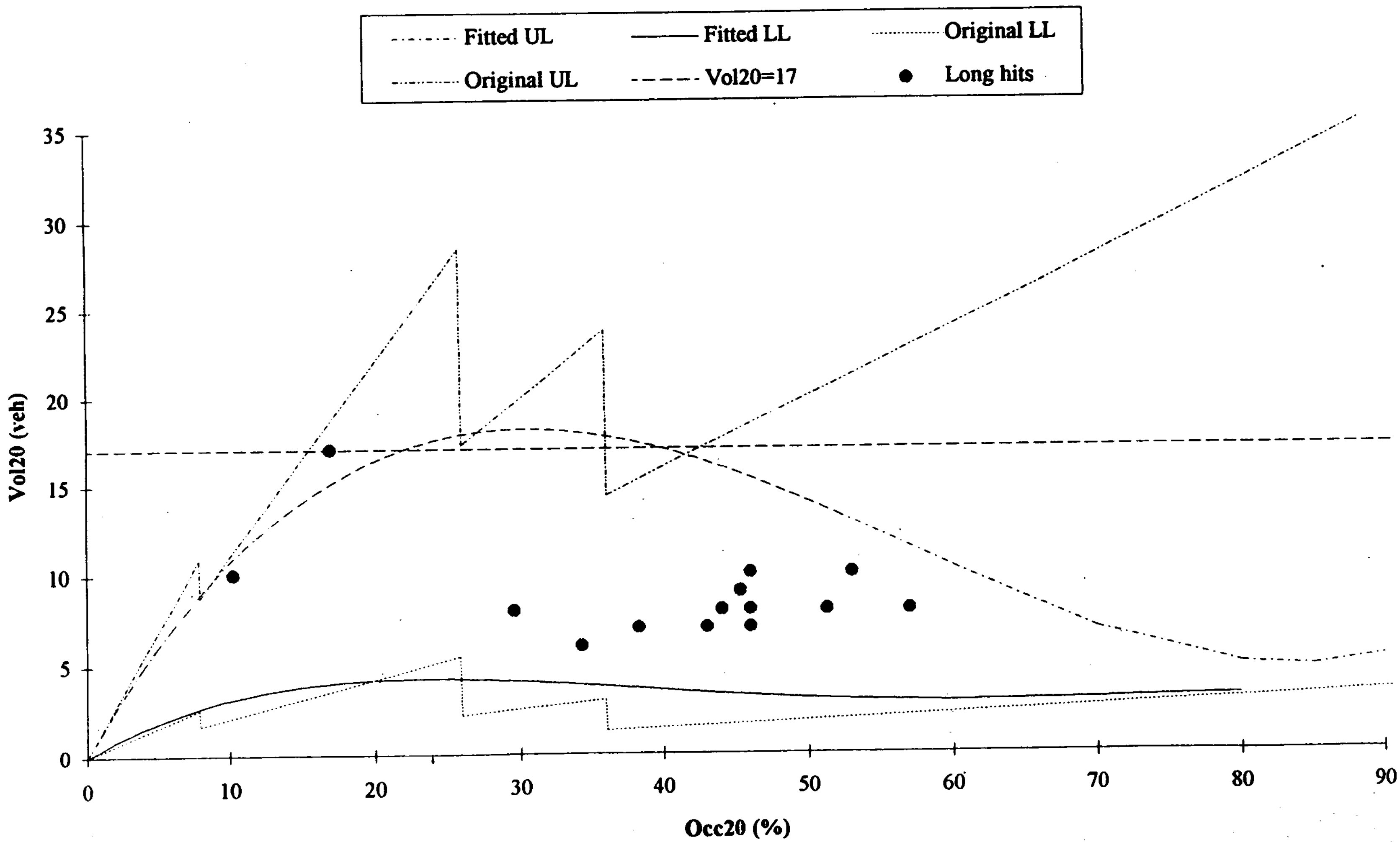


9/13, Det# 781, Longhits, N 145 SB, 16:17, shoulder, -0.76 grade



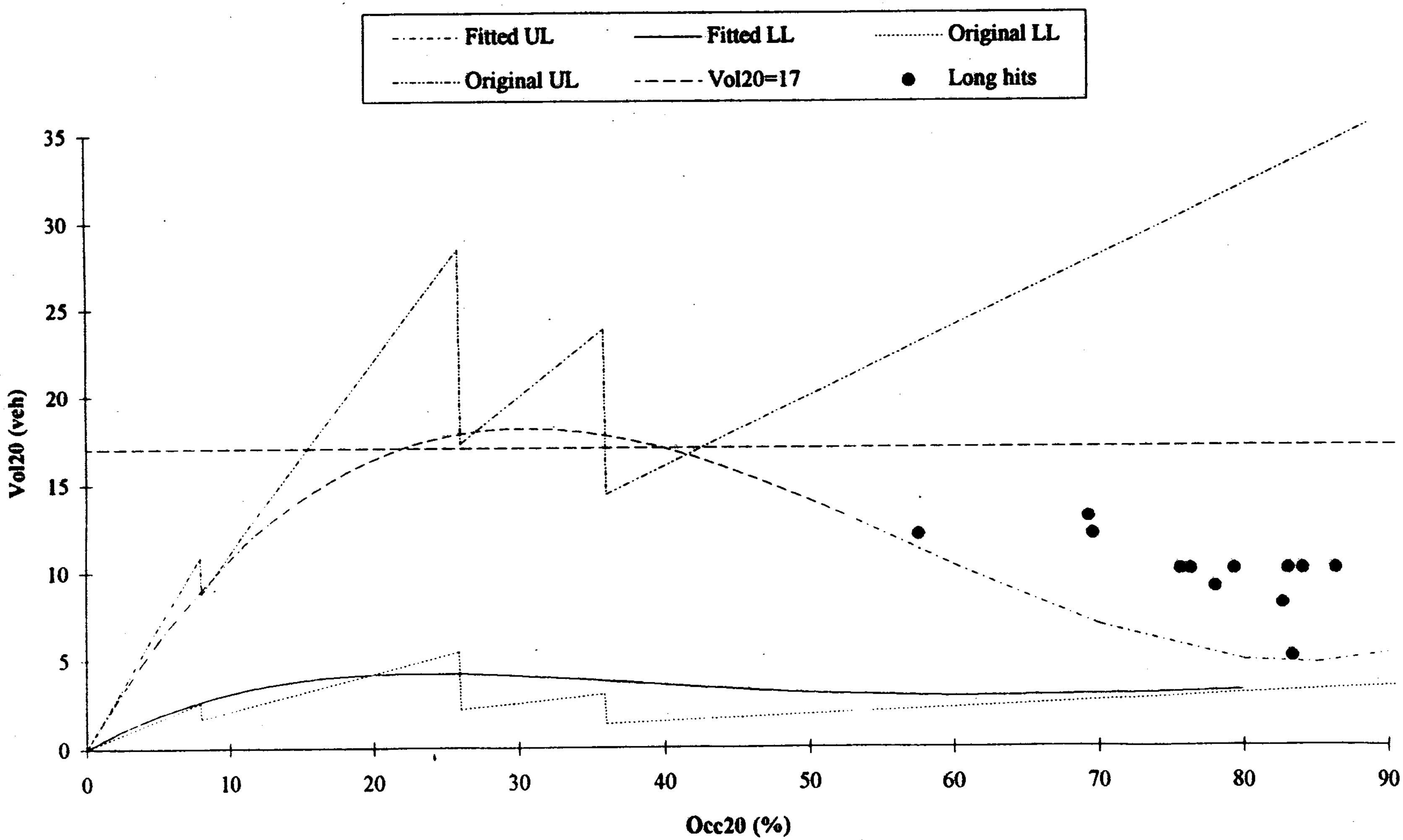
9/13, Det# 877, Longhits, N 205 SB, 15:57, median, 0.72% grade

Fitted Plot (Alt. C)



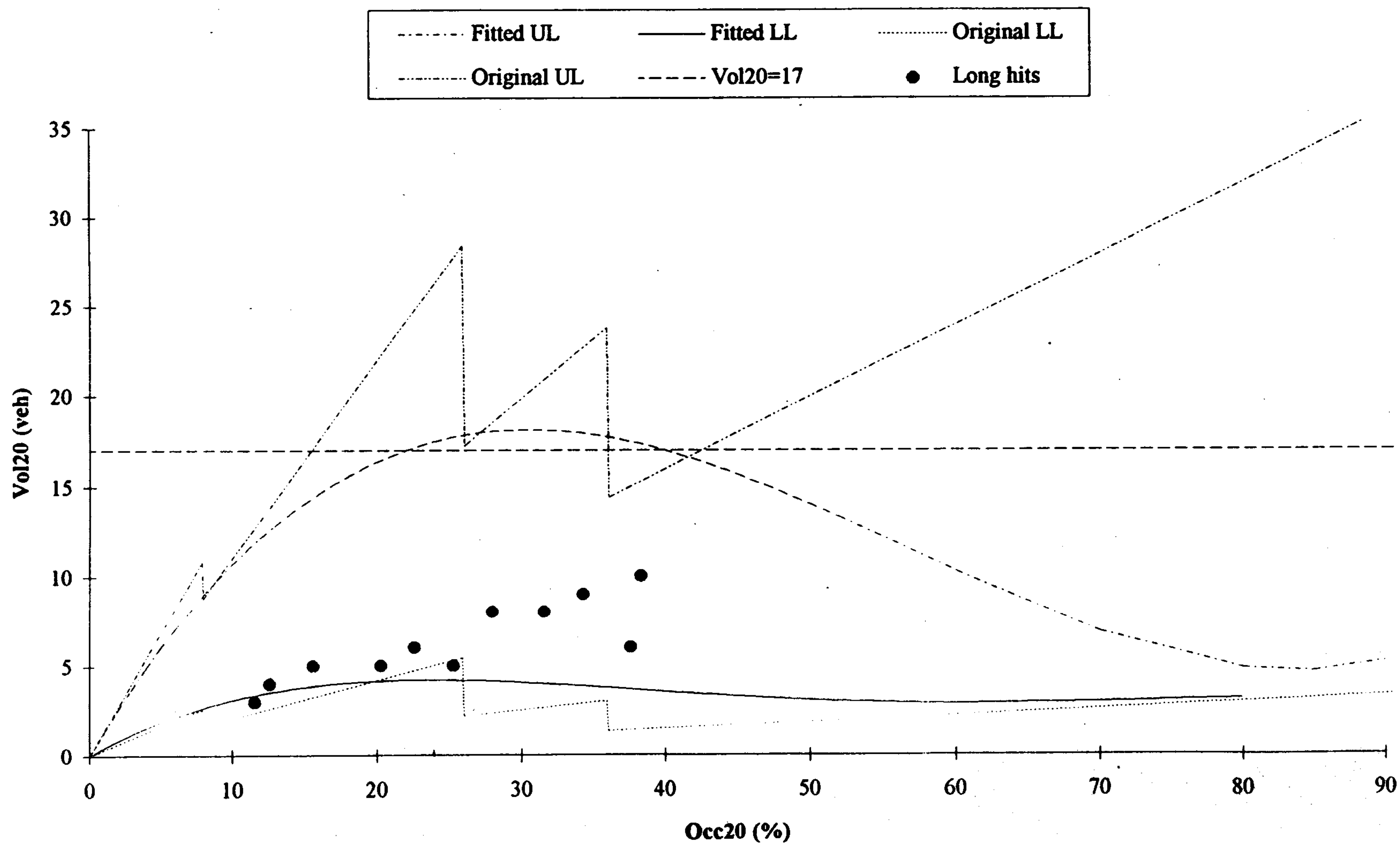
9/13, Det# 879, Longhits, N 205 NB, 15:57, center, -0.72 grade

Fitted Plot (Alt. C)

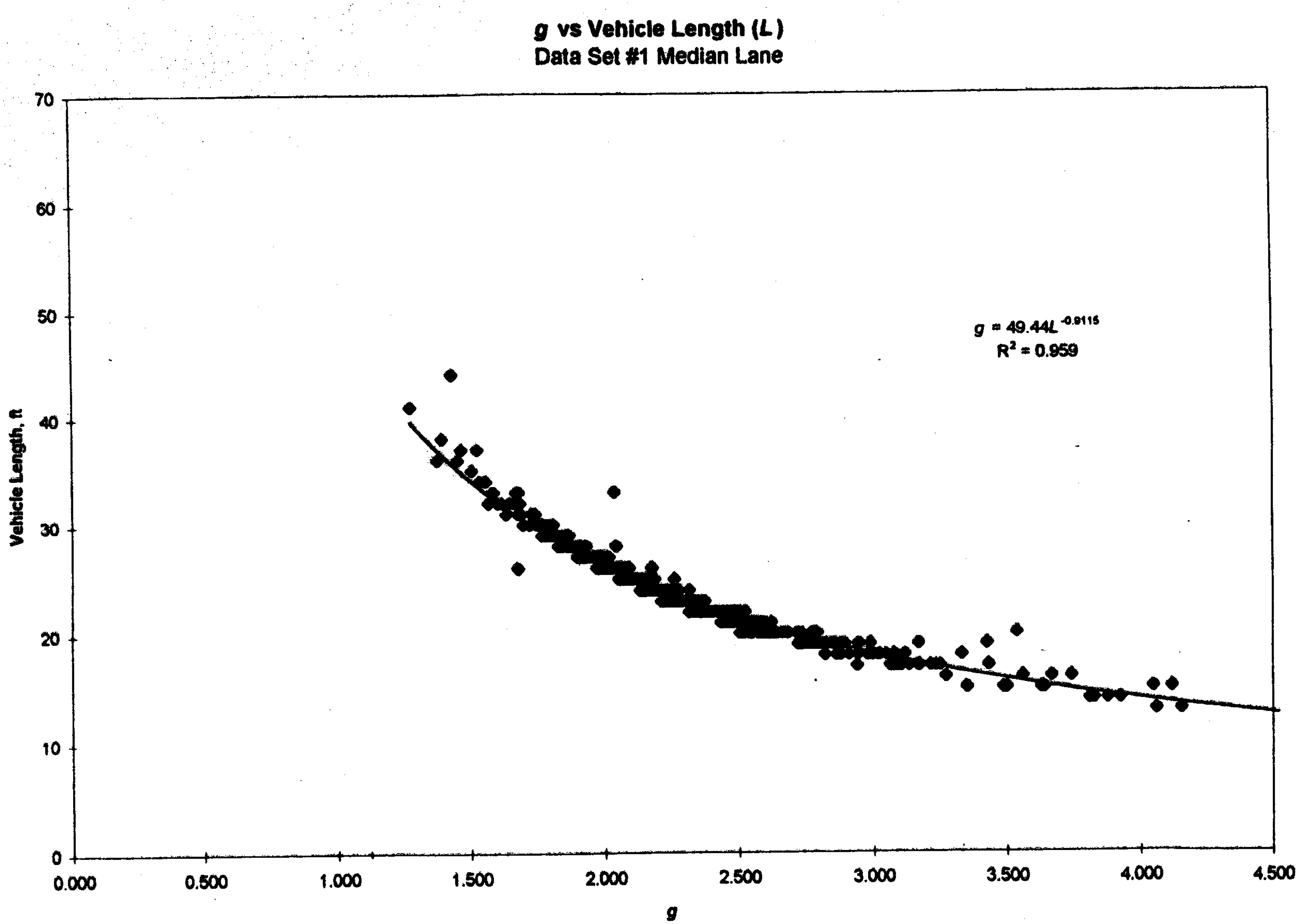


9/13, Det# 910, Longhits, N 130 SB, 9:16, Center right, 2.04% grade

Fitted Plot (Alt. C)

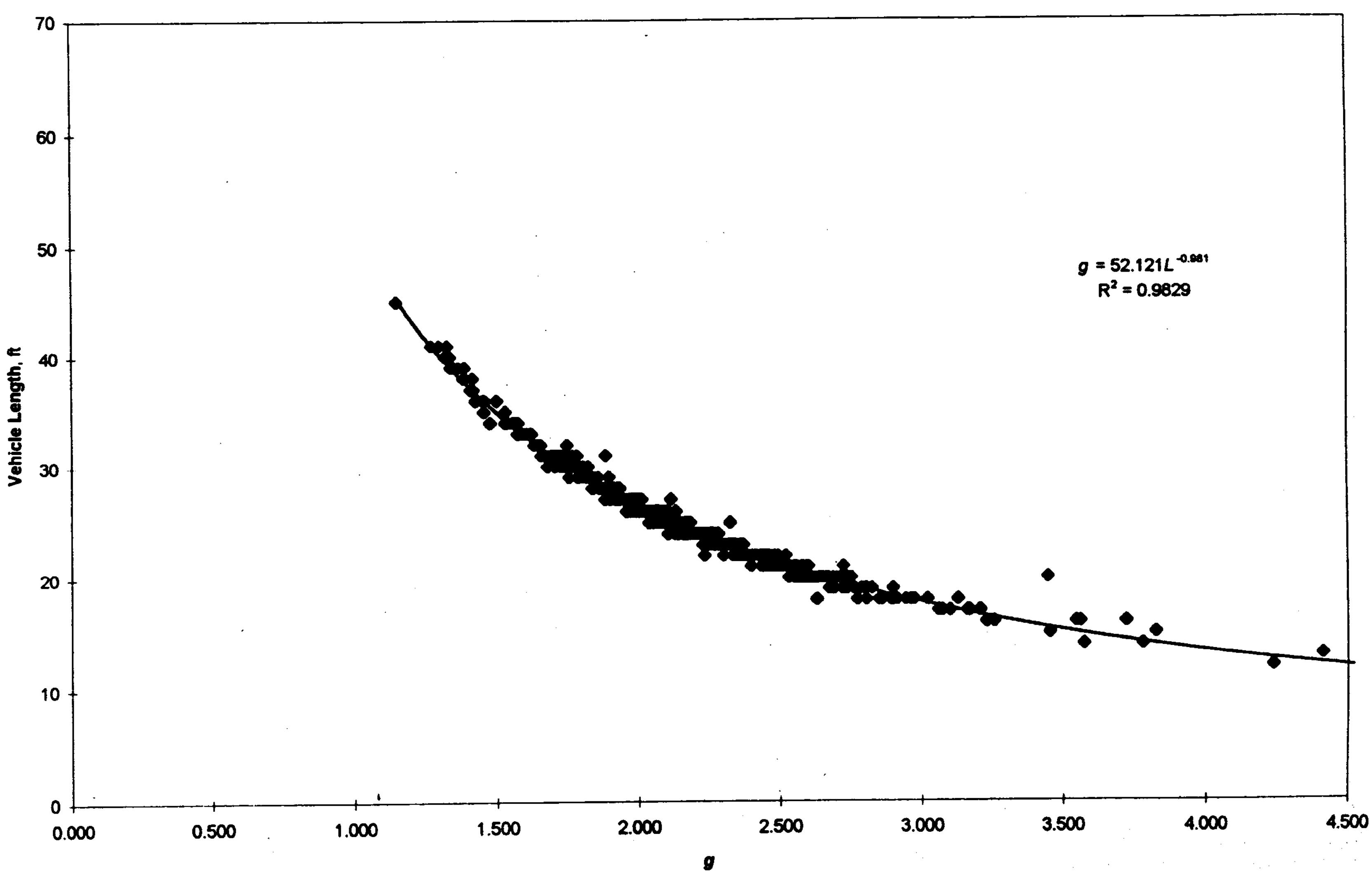


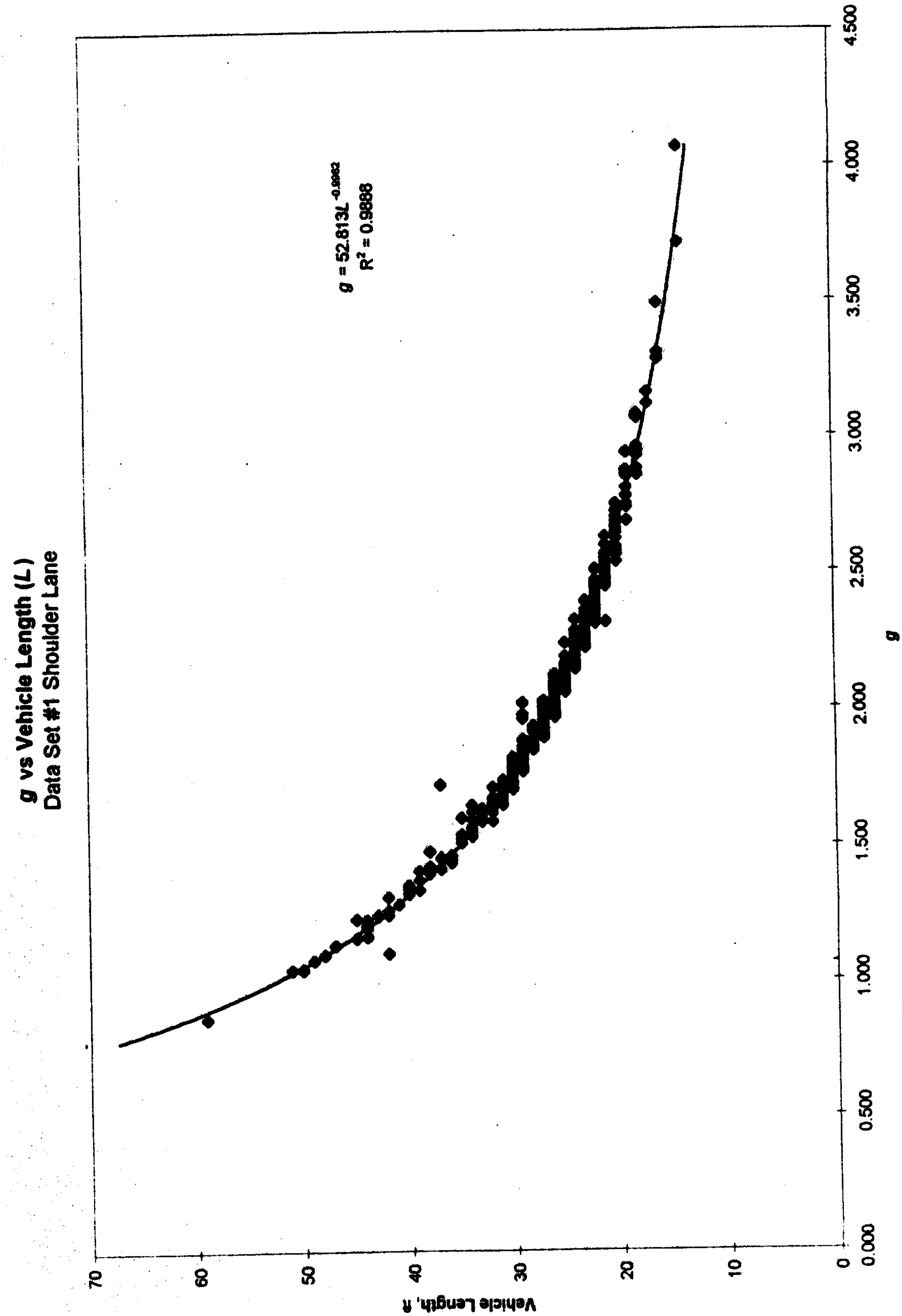
Appendix F Vehicle Length vs. *g*-Value Plots



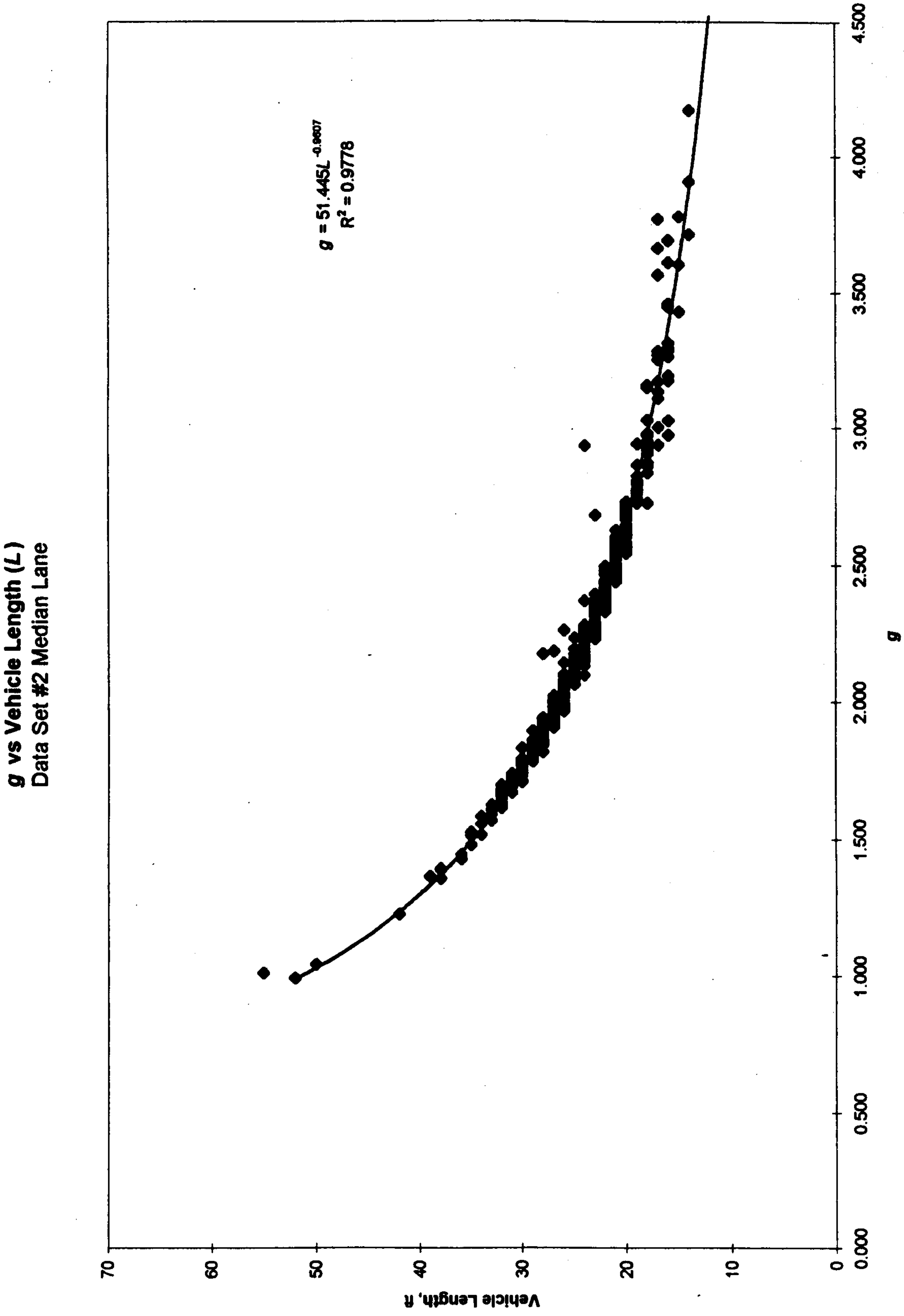
g vs Vehicle Length (L)
Data Set #1 Median Lane
g = 49.44L-0.9115
R2 = 0.959
Vehicle Length, ft
g
70
60
50
40
30
20
10
0
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500

g vs Vehicle Length (L)
Data Set #1 Center Lane

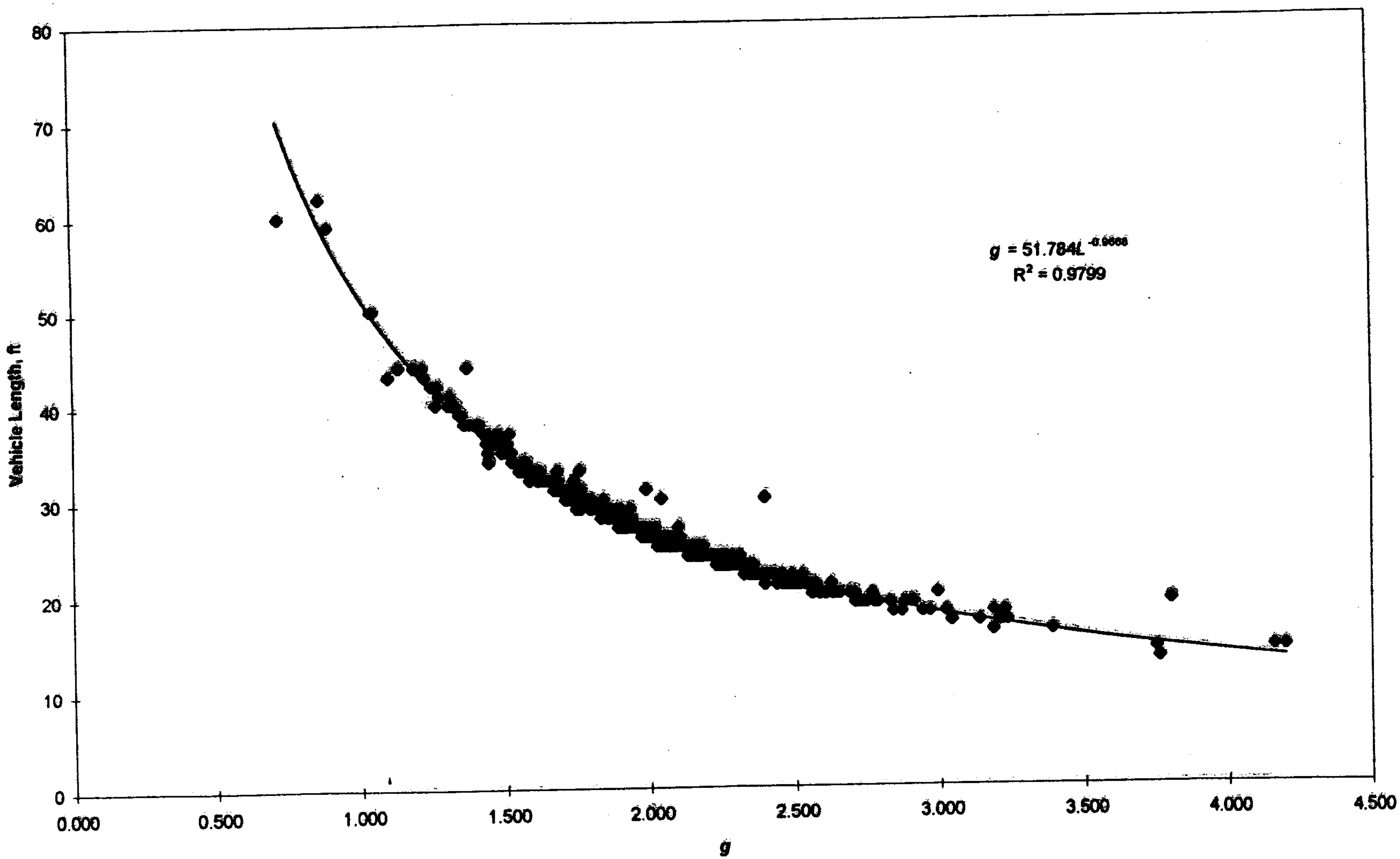




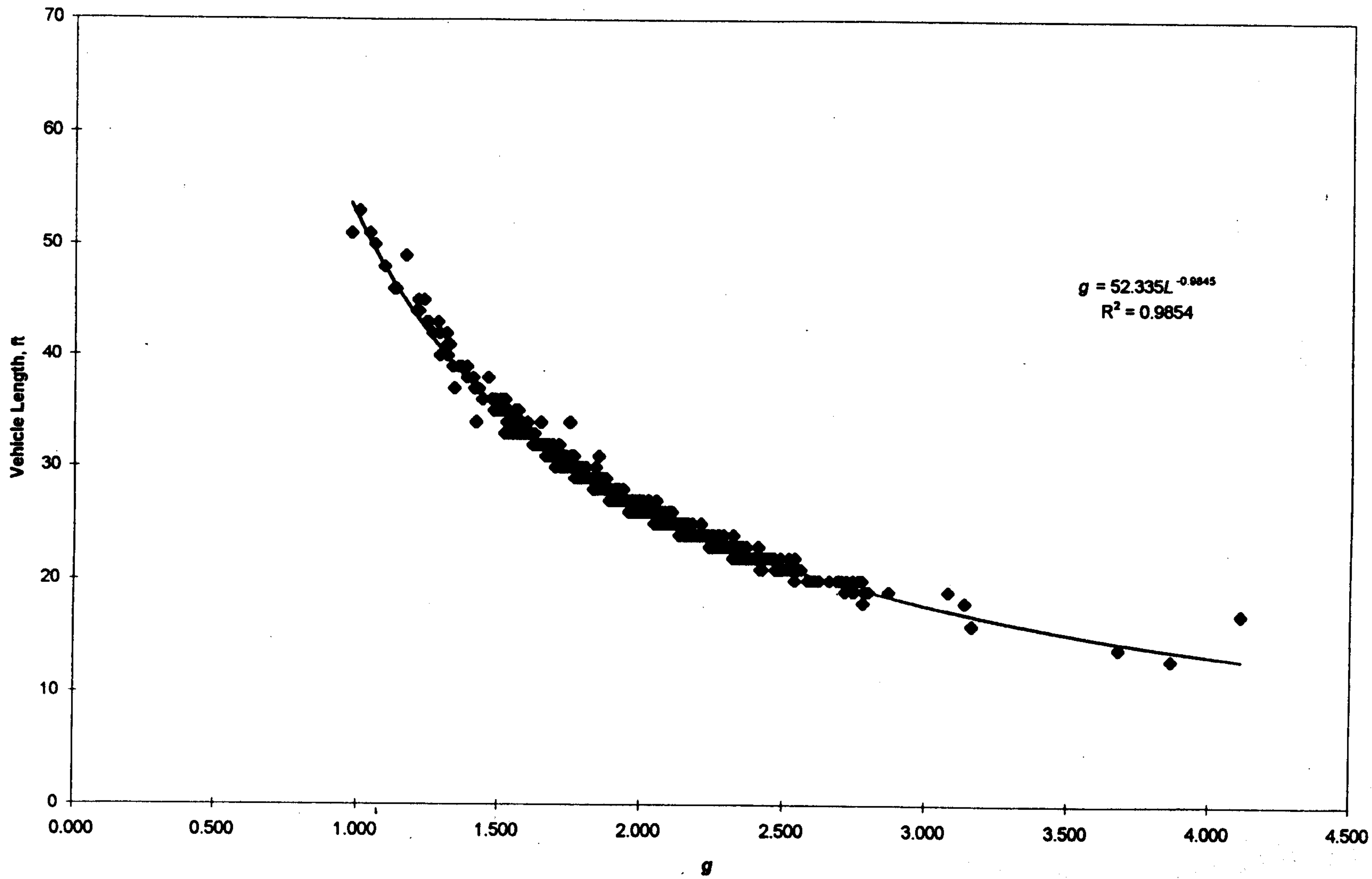
g vs Vehicle Length (L)
Data Set #1 Shoulder Lane
g = 52.813L^-0.9962
R² = 0.9888
Vehicle Length, ft
g
0
10
20
30
40
50
60
70
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500


g vs Vehicle Length (L)
Data Set #2 Median Lane
g = 51.445L^-0.9607
R² = 0.9778
Vehicle Length, ft
g
0
10
20
30
40
50
60
70
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500

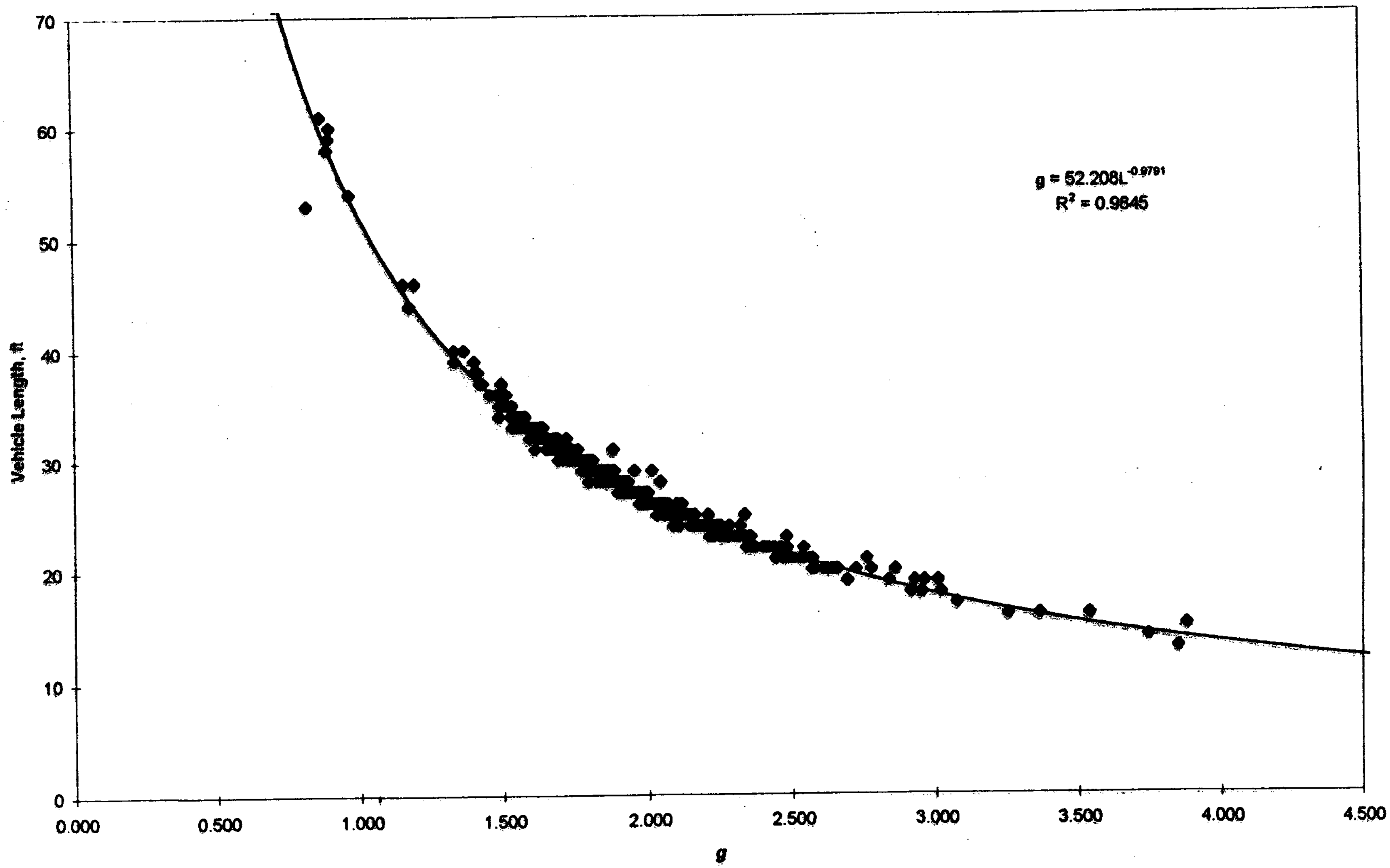
g vs Vehicle Length (L)
Data Set #2 Center Lane



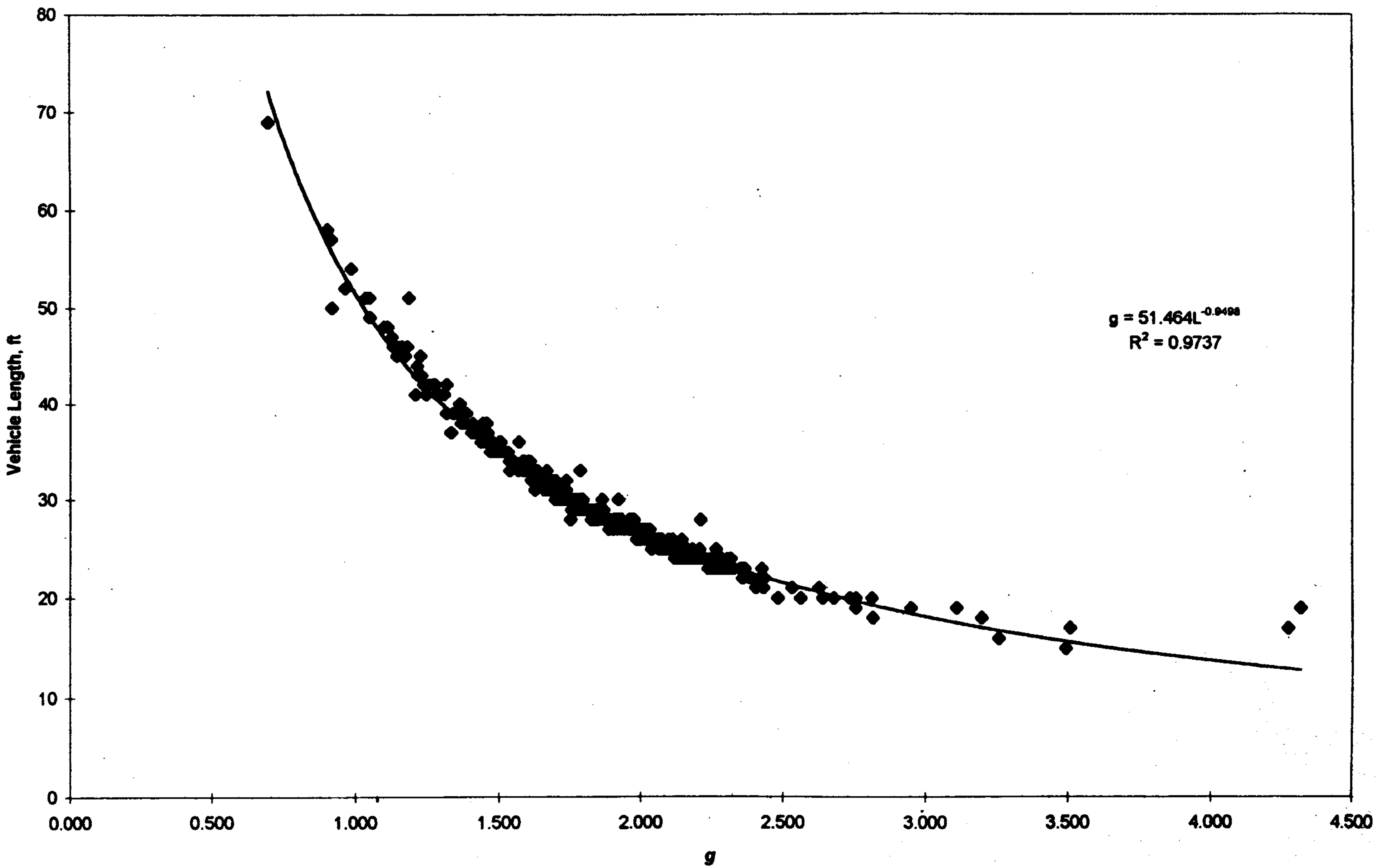
g vs Vehicle Length (L)
Data Set #2 Shoulder Lane



g vs Vehicle Length (L)
Data Set #3 Median Lane



g vs Vehicle Length (L)
Data Set #3 Center Lane



***g* vs Vehicle Length (*L*)**
Data Set #3 Shoulder Lane